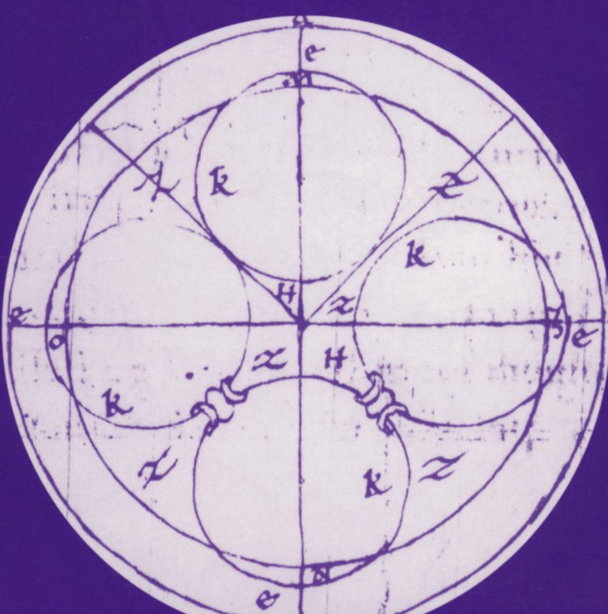
Planetary Diagrams for Roman Astronomy in Medieval Europe, ca. 800–1500

Bruce Eastwood

Gerd Graßhoff



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PLANETARY DIAGRAMS FOR ROMAN ASTRONOMY IN MEDIEVAL EUROPE, CA. 800-1500

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To Marshall Clagett

Contents

PREFACE

For more than twenty years, one of us (Bruce Eastwood) has been studying the texts and manuscripts of four Roman works. These are Pliny the Elder's *Natural History*, Macrobius's *Commentary on Cicero's Somnium Scipionis*, Martianus Capella's *Marriage of Philology and Mercury*, and Calcidius's *Commentary on the Timaeus of Plato*. Manuscripts of these works multiplied during the ninth century, in the culture of the Carolingian renaissance, and each of the works contained or stimulated astronomical diagrams that can reveal to moderns certain concerns of the Carolingian scholars and leaders involved. An important stimulus for the present work was the discovery that early medieval astronomy, especially in the era of Charlemagne and his successors, consisted of texts that went far beyond the boundaries of computus, which modern scholars have long believed to be the only significant context for astronomical studies of that time. It became apparent early that the texts sometimes contained varying or innovative diagrams where no other sign of divergence from the text could be seen. Such diagrams were not necessarily corruptions or errors; they were frequently found to provide indications of understandings of the texts—understandings different from those of modern scholars and generally ignored by editors of the texts. Furthermore the traditions of these diagrams lasted in many cases from the Carolingian era to the fifteenth century.

Over the years Eastwood collected a large number of microfilms of the manuscripts of the four texts and of other texts using any of the planetary diagrams derived from the four Roman texts. He carried out the initial locating and identifying of all the diagrams referred to in the present work. In the summer of 1997 the two of us came together for three months at the Max Planck Institute for History of Science in Berlin to work directly on the present compilation and analysis of the planetary diagrams. In the summer of 1999 we were, again at the Institute in Berlin, able to work together intensively to follow up our basic work of two years earlier. Finally, in the summer of 2001 we completed the scholarly tasks needed for our work. The long preparatory work by Eastwood was supported generously at different times by the National Science Foundation, the Institute for Advanced Study (Princeton), and the American Philosophical Society and by frequent summer research grants from the University of Kentucky. The collaborative stage, from 1997 onward, was generously supported especially by the Max-Planck-Institut-fur-Wissenschaftsgeschichte (Berlin) and by both the Deutsche Akademische Austauschdienst and the National Science Foundation as

well as the University of Kentucky. Without these many sources of support over the years this project could never have been completed, and we are extremely grateful to each of these institutions for helping to make this work possible.

Regarding our collaboration, we want to emphasize that although Eastwood contributed the microfilms and the data about the manuscripts and the diagrams, it was the conversations between us primarily during each of the three summer sessions of work together, that produced the final separations and classifications of the individual diagrams. Often it would seem at first to us that a diagram was referring to a doctrine of one author, Martianus Capella for example, when further questioning and analysis would then show us the error of our preliminary assessment and lead us to assign the diagram in question to a doctrine of a different author, Macrobius for example. Correct assignment of a diagram to its originating text was not always obvious or easy, and our give-and-take in discussing such questions has made the final result in this work far superior to what either of us could have accomplished without the other. Finally, the organization of the work in its present form, while requiring consultation between us, is almost completely the contribution of Graßhoff. The format and detailed appearance of all the information and illustrations is his work. For locating and entering into this format the texts, illustrations, and all other information, we owe unending thanks to Hans-Christoph Liess for his innumerable hours of work from the beginning of this project in 1997 to its completion. In the end, we two coauthors are mutually responsible for the full content of this study.

ABBREVIATIONS OF LIBRARY NAMES

BA	Biblioteca Ambrosiana
BAV	Biblioteca Apostolica Vaticana
BB	Burgerbibliothek
BC	Biblioteca comunale
Bcap	Biblioteca Capitolare
BL	British Library
Bist	Bistumsarchiv
BM	Bibliothèque municipale
BML	Biblioteca Medicea Laurenziana
BN	Biblioteca Nazionale
BNF	Bibliothèque nationale de France
BoL	Bodleian Library
BR	Bibliothèque Royale (Brussels)
BRc	Biblioteca Riccardiana (Florence)
BU	Biblijoteka Uniwersytetu (Poland), Bibliothèque universitaire (France)
BUJ	Biblijoteka Uniwersytetu Jagiellonskiego
BVall	Biblioteca Vallicelliana
BVil	Bibliothèque de la Ville
CL	College Library
DB	Dombibliothek
FB	Fondation Bodmer
FM	Fitzwilliam Museum
HAB	Herzog August Bibliothek
HL	Houghton Library
KB	Kongelige Bibliotek
KM	Knihovna Metropolitní Kapituly
LB	Landesbibliothek
NB	Nationalbibliothek
NLW	National Library of Wales
RB	Real Biblioteca
SB	Staatsbibliothek

SK	Státní knihovna
StB	Stadtsbibliothek
StiB	Stiftsbibliothek
UB	Universitätsbibliothek (Germany), Universiteitsbibliotheek (Netherlands)
UL	University Library
WAG	Walters Art Gallery
ZB	Zentralbibliothek

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Capella (1977). *Martianus Capella and the Seven Liberal Arts, II: The Marriage of Philology and Mercury*, transl. W. H. Stahl and R. Johnson with E. L. Burge. New York: Columbia University Press, 1977. © 1977 Columbia University Press. Quotations in Chapter V are reprinted with the permission of the publisher.

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Eastwood (1982a). Bruce Eastwood, "Kepler as Historian of Science: Precursors of Copernican Heliocentrism According to *De revolutionibus I*, 10," *Proceedings of the American Philosophical Society*, 126 (1982), 367-94. Quotation in Chapter III is used with permission of the American Philosophical Society.

Eastwood (1982b)."'The Chaster Path of Venus' (*orbis Veneris castior*) in the Astronomy of Martianus Capella," *Archives internationales d'histoire des sciences*, 32 (1982), 145-58.

Macrobius (1952). Macrobius, *Commentary on the Dream of Scipio*, transl. W. H. Stahl. New York: Columbia University Press, 1952. © 1990 Columbia University Press. Quotations in Chapter III are reprinted with the permission of the publisher.

Macrobius (1970). Ambrosius Theodosius Macrobius, *Commentarii in somnium Scipionis*, ed. J. Willis. Leipzig: Teubner, 1970. © K. G. Saur, München/Leipzig. Quo-

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Plinius (1888). *Auszüge aus der Naturgeschichte des C. Plinius Secundus in einem astronomisch-komputistischen Sammelwerke des achten Jahrhunderts*, ed. K. Rück. Programm des Königlichen Ludwigs-Gymnasiums für das Studienjahr 1887/88. Munich: F. Straub, 1888.

Chapter I

INTRODUCTION

1 Astronomy and Its Teaching in Carolingian Europe

From the sixth to the twelfth centuries in western Europe, it has long been assumed that there was no scientific development of any significance. For intellectual or cultural advance in general, the one interval that has found recognition for its artistic achievements, its revival of classical Latin writings, and its reform of script for copying and preserving texts of all sorts is the Carolingian age, from the rule of Charlemagne (768-814) through the ninth century and into the tenth. While this interval has traditionally been emphasized as a high point of temporary cultural renewal rising above a surrounding five-century depression, the achievements of the Carolingians have not seemed to include any remarkable activity in the natural sciences, certainly not in astronomy.[1]

Studies in recent years, especially from the 1970s forward, have begun to change our view of Carolingian sciences. In his lengthy directions to the clergy in 789, the *Admonitio generalis (General Directives)*, Charlemagne required the study not only of grammar, writing, and chant, but also of computus. It is possible to categorize computus as the arithmetical computation of the date of Easter and all the other feast days of the Christian calendar that depend on it. However, this definition presumes much and omits more. It presumes the basic luni-solar astronomy behind the determination of the equinoxes, basic to any Easter dating, and it omits a body of knowledge about the twelve signs of the zodiac that came to be part of computistical competency in the Carolingian era, if not earlier. The history of computus in the early Middle Ages has gradually come to include the historical reacquisition of these kinds of astronomical knowledge by clerical scholars of the seventh to ninth centuries. We have come to see its development not simply as a series of limited arguments over arithmetical intervals of lunar and solar phenomena, but rather as a development of concern for increasing precision and for knowledge of the grounds for increased precision in measuring time. Recent

[1]The traditional approach, at least with respect to the natural sciences, occurs in the following volumes that have already become standard references. Rosamond McKitterick, ed., *Carolingian Culture: Emulation and Innovation* (Cambridge: Cambridge University Press, 1994); Rosamond McKitterick, ed., *The New Cambridge Medieval History, Volume II: c. 700-c. 900* (Cambridge: Cambridge University Press, 1995). Neither of these volumes has a chapter or major section on science, although the latter has a discussion (pp. 739-45) of numeracy, computus, astronomy, and music within a section on educational curriculum.

scholarship has focused also on the motives for reforms made in computus and calendar construction in the early Middle Ages, integrating ecclesiastical, liturgical, even ideological, and scientific considerations in the history of computus. In these various ways the history of computus in the Carolingian world has become an intriguing, multifaceted study.[2] While computus in the Carolingian era is now the subject of many-sided historical study, there are many facets of Carolingian astronomy that were beyond the range of computistical interest. The explanation of the different lengths of the four seasons and the explanation of eclipses are examples of luni-solar topics not included in standard computus, and no details of the orbits of the other five planets were included. Planetary astronomy was not a part of computus. The continuous courses of the planets through their orbits were not of interest in computistical study. Geometrical explanation was not a part of computus. To find discussions of these topics among Carolingian scholars we must go to readings of, excerpts from, and comments on classical Latin works that were revived, copied, disseminated, and studied from the time of Charlemagne onward.

The Carolingian revival of ancient Latin authors has been widely studied, yet the reasons for interest in many individual writers and works remain to be clarified.[3] However, we can discern some fundamental goals that called for the study of astronomy, a concern of certain ancient Roman writers, well beyond the content of computus. Charlemagne not only called for the clergy to study adequately grammar, writing, chant, and computus, but also, in his *Epistola de litteris colendis (Letter on the cultivation of learning)* to Abbot Baugulf and others (780-800), he urged the broader study of letters among those clerics who were able to learn more than the necessary basic knowledge. Further in the same vein, Alcuin (ca. 730-804), advisor to the king and abbot of Tours, composed an introduction to the study of grammar, written while he was at the royal court at Aachen, in which

[2]There is a vast technical literature on computus. An introduction to various aspects of its history and context can be found in the following works: Olaf Pedersen, "The Ecclesiastical Calendar and the Life of the Church," in G. V. Coyne et al., ed., *Gregorian Reform of the Calendar* (Vatican City: Pontificia Academia Scientiarum, 1983), pp. 17-74; Richard Landes, "Lest the Millenium Be Fulfilled: Apocalyptic Expectations and the Pattern of Western Chronography 100-800 C.E.," in W. Verbeke et al., ed., *The Use and Abuse of Eschatology in the Middle Ages* (Leuven: Leuven U. P., 1988), pp. 137-211; Arno Borst, *The Ordering of Time*, tr. A. Winnard (Chicago: University of Chicago Press, 1993); Wesley Stevens, *Cycles of Time and Scientific Learning in Medieval Europe* (Aldershot: Ashgate, 1995), chs. 1, 2, 4, 5, 9; Stephen McCluskey, *Astronomies and Cultures in Early Medieval Europe* (Cambridge: Cambridge U.P., 1998), chs. 5, 8; Bede, *The Reckoning of Time*, tr. and comm. Faith Wallis (Liverpool: Liverpool U.P., 1999), esp. pp. xv-lxxxv.

[3]A good introduction to the revival and a consideration of the term *renaissance* appears in Giles Brown, "Introduction: the Carolingian Renaissance," in R. McKitterick, ed., *Carolingian Culture*, pp. 1-51. An excellent example of the varied Carolingian reasons for study of a discipline is the essay by Vivien Law, "The study of grammar," in ibid., pp. 88-110.

he emphasized the need for religious students to learn all of the seven liberal arts, which included four mathematical arts, one of which was astronomy. He considered them steps in the ladder to higher wisdom, being gifts of God through the Holy Spirit and enabling students to achieve fuller knowledge of the Scriptures and arming them properly to defend the true doctrines of the Church.[4]

For both Alcuin and Charlemagne astronomical study and phenomena held high interest. Alcuin wrote to discuss with the king the sudden reappearance of Mars in July of 798 after a year of invisibility, attributing the phenomenon to planetary retrogradation.[5] They also exchanged letters about computistical matters.[6] When Alcuin was deceased, Charlemagne continued to seek astronomical expertise, for example, from the Irish monk Dungal in 811, when the king sent to Paris to ask him how to account for the two solar eclipses supposed to have occurred—only one was observed in the West—in one year, the year 810, which had been reported by a member of an episcopal embassy visiting Aachen from Constantinople.[7] After the king's death his biographer, Einhard, pointed to the special interest of Charlemagne in astronomy and his great curiosity about "the movement of the stars."[8] From the time of the great king and emperor onward, we find evidence of serious astronomical study and investigation by figures at the royal court and by certain clerical teachers and scholars.[9]

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[4]Alcuin, "Grammatica," in J. P. Migne, ed., *Patrologia Latina* 101, coll. 849-54. See esp. the articles of Louis Holtz, "L'enseignement de la grammaire au temps de Charles le Chauve," in C. Leonardi, ed., *Giovanni Scoto nel suo tempo* (Spoleto: C.I.S.A.M., 1989), pp. 153-69; idem, "Alcuin et la renaissance des arts libéraux" in P. Butzer et al., ed., *Karl der Grosse und sein Nachwirken, I: Wissen und Weltbild*(Turnhout: Brepols, 1997), pp. 45-60, esp. 54-9.

[5]E. Dümmler, ed., Monumenta Germaniae Historica (MGH), Epistolae, IV: *Epistolae Karolini Aevi*, 2 (Berlin: Weidmann, 1895), pp. 243, 251-2.

[6]For example, ibid., pp. 250, 279-80.

[7]Ibid., p. 570, ll. 12-18. A large and somewhat redundant body of literature has been concerned to point out that these two solar eclipses could not have been observed in the West. Neither Charlemagne nor Dungal ever claimed two solar eclipses were or could have been observed in their regions. The qualifications of this report are brief but clear in the text cited.

[8]Einhard, *Vita Karoli Magni*, 25, ed. O. Holder-Egger, MGH Scriptores rerum Germanicarum separatim 25 (Hannover: Hahn, 1911), p. 30; a useful recent translation is by P. E. Dutton, ed. and tr., *Charlemagne's Courtier: The Complete Einhard* (Peterborough, Ont.: Broadview Press, 1998), p. 32.

[9]With regard to interest at the royal court of Louis the Pious we can note the production of the marvelous Aratea ms., Leiden UB ms. Voss. lat. Q. 79 by a workshop associated with his court; see Bernhard Bischoff et al., *Aratea. Kommentar zum Aratus des Germanicus MS. Voss. Lat. Q. 79* (Luzern: Faksimile Verlag, 1989), pp. 14, 65. Of special interest for inclusion of elements of the astronomies of Pliny the Elder and of Martianus Capella is a planetary configuration on folio 93v in this Aratea ms.; on that image and its presentation of a date for the year 816 see Bruce Eastwood, *The Revival of Planetary Astronomy in Carolingian and Post-Carolingian Europe* (Aldershot: Ashgate, 2002), ch. 4 and Addenda and Corrigenda thereto. Further evidence from Louis' court is the presence of the anonymous biographer known as "Astronomus," so named because of his

Because the achievements of the Hellenistic astronomers, preeminently Hipparchus and Ptolemy, were unavailable to European scholars of the early Middle Ages, they depended for their knowledge of astronomy on the fragments, summaries, and philosophical commentaries in Latin that survived from Roman writers. Before the Carolingian revival, very little even of these Roman sources found attention or use for astronomy; computistical interests were the center of inquiries in the seventh and eighth centuries. (The evidence of Irish observations of eclipses and other phenomena for eschatological reasons can be added here, but it does not lead to different conclusions about planetary astronomy.[10]) During the Carolingian era there reappeared four Roman works containing information about the planets that scholars of the time found especially useful and important. These were Pliny's *Natural History*, Macrobius' *Commentary on the Dream of Scipio*, Martianus Capella's *Marriage of Philology and Mercury*, and Calcidius' *Commentary on Plato's Timaeus*.

The *Natural History* of Pliny was well known to and used by Alcuin and the king in their astronomical correspondence.[11] In 809 Charlemagne called a conference for computistical reforms, and astronomical excerpts from Pliny regarding the planets were included in a collection of the texts brought together as a result of this conference. Since the original text of Pliny's work included no diagrams, these excerpts had illustrative diagrams added to them for four attributes of the planets.[12] We can see the application of a Plinian diagram for one of these at-

inclusion of celestial phenomena in his account. See *Quellen zur karolingischen Reichsgeschichte, I: Die Reichsannalen*, ed. R. Rau, *Ausgewählte Quellen zur deutschen Geschichte des Mittelalters*, 5, ed. R. Buchner (Darmstadt: Wissenschaftliche Buchgesellschaft, 1955), pp. 255-381. For the court of Charles the Bald we have the well known figure of John Scot Eriugena, now well connected to the royal court by the work of Paul Dutton, "Eriugena, the Royal Poet," in G. Allard, ed., *Jean Scot Ecrivain. Actes du IVe Colloque international, Montréal, 28 août - 2 septembre 1983* (Montréal: Bellarmin, 1986), pp. 51-80. Both the commentary of Eriugena on the work of Martianus Capella sometime in the 850s and elements in his *Periphyseon* of the 860s display his astronomical interest and knowledge; on Eriugena's astronomy see Bruce Eastwood, "Johannes Scottus Eriugena, Sun-Centred Planets, and Carolingian Astronomy," *Journal for the History of Astronomy*, 32 (2001), 281-324.

[10]See the excellent report on this by Daniel McCarthy and Aidan Breen, "Astronomical Observations in the Irish Annals and Their Motivations," *Peritia*, 11 (1997), 1-42.

[11]Dümmler, MGH *Ep. Kar. Aev.*, 2, pp. 250, 280.

[12]Regarding the excerpts in the Carolingian world see Vernon King, "An Investigation of Some Astronomical Excerpts from Pliny's Natural History Found in Manuscripts of the Earlier Middle Ages," B. Litt. Thesis, Oxford University, 1969, pp. 2-79. On the collection of the texts after the conference of 809, see Arno Borst, "Alcuin und die Enzyklopädie von 809," in P. Butzer et al., *Science in Western and Eastern Civilization in Carolingian Times* (Basel: Birkhäuser, 1993), pp. 53-78. On the diagrams added to the excerpts see Bruce Eastwood, "Plinian Astronomical Diagrams in the Early Middle Ages," in E. Grant et al., *Mathematics and Its Applications to Science and Natural Philosophy in the Middle Ages. Essays in Honor of Marshall Clagett* (Cambridge: Cambridge U.P., 1987), pp. 141-72.

tributes, the apogees/apsides of the planets (described below), in the planetary configuration designed during or after the year 816 in the palace artistic school.[13] The four Plinian diagrams appeared throughout the ninth century and beyond, both in connection with their texts (the excerpts) and independently, as they were found useful even without the texts. Their subjects were planetary order, harmonic intervals, apsides, and latitudes. Each diagram reiterated the simple information in the excerpt it was designed to accompany. The diagram for planetary order gave a picture of nine concentric circles, one for each of the planets and one each for the central earth and the outermost stellar sphere. The diagram for planetary harmonic intervals followed and built on the first, setting the concentric circles at different intervals of separation, depending on the number of "tones" (in small integers and halves) that Pliny said should separate them. The diagram for apsides, or apogees, showed the location in its circular orbit of the far point from the earth for each planet. In this diagram the planets were reoriented, no longer on concentric circles but rather all on eccentric circles around the earth, which remained central within the stellar sphere but not in relation to the planets. Being on an eccentric circle, each planet obviously would have a near point and a far point with respect to the earth, around which it circled. Finally, the fourth diagram presented the latitudes of the planets according to a simple list of numbers provided by Pliny. Given that the Sun circles the earth on a plane called the ecliptic and that all the other planets circle the earth in orbits at small angles to that plane, Pliny listed the number of degrees for the angle of inclination of each planetary circle with respect to the plane of the ecliptic. The diagram represented the motion of each planet at its unique angle in its semicircle above the ecliptic and its subsequent semicircle below the ecliptic. The four diagrams incorporated the general circularity of planetary orbits. Beyond that, each diagram set forth only one attribute of the planets—order, intervals, apsides, or latitudes—ignoring the other attributes and combining all the planets in each diagram to represent the attribute concerned. These diagrams were excellent tools for use in teaching the Plinian material of the excerpts. Just as various teaching masters from Bede to Rabanus Maurus and beyond had suggested, oral instruction and visual images could often improve the clarity and heighten the retention of such astronomical data as Pliny had presented.[14]

[13]See n. 9 regarding the image of Leiden UB ms. Voss. lat. Q. 79, f. 93v.

[14]St. Augustine mentions in *Confessions* IV.16 (28) that the teaching of Aristotle's logic is done both through lectures and through numerous diagrams "drawn in the dust," possibly on the ground or on a table; see *Confessionum libri XIII*, ed. Martin Skutella et al. (Stuttgart: Teubner, 1969), pp. 73.30-74.2. At the end of his book on geometry the late-fifth-century encyclopedist Martianus Capella wrote of geometrical demonstrations "in the dust," the powder on a board kept by teachers for the purpose of drawing and redrawing images as needed for the instruction of students; see *Martianus Capella*, ed. James Willis (Leipzig: Teubner, 1983), 258.3 (VI, 722). The ninth-century scholar and teacher

The persistence of clear and simple diagrams is shown by the history of the diagram for planetary order accompanying Macrobius' *Commentary on the Dream of Scipio* (ca. 430), a lengthy elaboration on a brief text of Cicero. The earliest surviving manuscripts of this commentary from the ninth and tenth centuries all have the same diagram to illustrate the sequence of the planets between the earth and the outer, stellar sphere, as an aid to a text in which Macrobius himself remarked that a diagram often clarifies a verbal image greatly.[15] Even though the order of the planets would seem to moderns to be an uncomplicated problem, the diagram for this topic in the text of Macrobius was often copied out into other texts, presumably because of its clarity. It showed equally spaced concentric circles for all seven planets from the earth to the stars. A further benefit of this diagram was its display of the twelve signs of the zodiac in twelve equal (30°) segments, arranged counterclockwise like the hours on a twelve-hour clock. This outer circular band of zodiacal signs is arranged around us on the plane of the ecliptic. In the geocentric world of ancient and medieval stellar astronomy, the zodiacal band is a circular strip, 12° in width, of the stellar sphere that surrounds us with its center line on the ecliptic and a great circle in the heavens. Macrobius's diagram presents it simply and unambiguously as the outer frame for the ordered planets.[16] There are two other astronomical diagrams in Macrobius' *Commentary* that were widely copied in excerpts of the ninth century, but these do not deal with the planets. Nonetheless their use by various scholars and teachers demonstrates

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Remigius of Auxerre, in commenting on this passage, clarifies this by noting that the phrase "in pulvere" refers to an *abacus*, or a board/tray covered with fine sand for calculations and diagrams. Regarding oral instruction Bede, *De ratione temporum* 4, 16, 55, wrote of the preference at times for oral over written instruction; see *Bedae venerabilis opera, VI: Opera didascalica, 2*, ed. Charles Jones, CCSL 123B (Turnhout: Brepols, 1977), pp. 281, 336, 444. Rabanus Maurus (ca. 780-856) likewise referred to what must have been a long-standing practice when he wrote of his preference for taking his students out to point out the constellations in the sky at night rather than depend on textbooks for such knowledge; see Rabanus Maurus, *Martyrologium. De computo*, ed. J. McCulloh and W. Stevens, CCCM 44 (Turnhout: Brepols, 1979), 252 (*De computo* 40).

[15] Ambrosius Theodosius Macrobius, *Commentarii in somnium Scipionis*, ed. James Willis (Leipzig: Teubner, 1970), p. 85.12-13 (I.xxi.3). The early manuscript diagrams show the planetary sequence as ed. Willis, p. 164, gives it. Later centuries tend to replace this with a very different and more correct diagram, as we show below (zodiacal diagrams labeled 2b in Chapter 3, Section 4). The image in the early mss. is the imposition of an early and influential teacher, Dungal, whose place in the history of this diagram in Macrobius mss. Bruce Eastwood discusses extensively in a separate, forthcoming publication.

[16] A good example of this Macrobian diagram and probably the earliest surviving example appears in Berlin, Staatsbibliothek zu Berlin, ms. Phillipps 1784 (Rose 177), f. 7r.

the importance of diagrams in the dissemination of astronomical doctrines in Carolingian schools.[17]

The texts of Pliny and Macrobius and their associated planetary diagrams appeared during the first two decades of the ninth century. These diagrams taught basic data and concepts. With the introduction and spread of the works of the other two Roman authors, Martianus Capella and Calcidius, came new and more sophisticated concepts about the motions of the planets. And with these works came more subtle, even problematical, diagrams. While the Plinian and Macrobian planetary diagrams provided images intended to convey information in the texts, the diagrams of Capella and Calcidius assumed a body of basic information and showed how to understand the texts. For example, Capellan diagrams assumed knowledge of epicyclic motion when offering different models for the motions of the two planets Mercury and Venus around the Sun, which carries them with it around the earth. (An *epicycle* is a small circle with its center revolving around the periphery of a larger circle, within which the earth is located; a planet revolves on the periphery of the epicycle in order to use the combined motions of the two circles to represent the motion of the planet.) And Calcidian diagrams assumed an understanding of relative motion. This occurred in the model for explaining the different lengths of the four seasons by means of a solar circle surrounding and eccentric to the earth, all of which was surrounded by a geocentric zodiacal band. Other diagrammed topics of planetary motions appeared in the Carolingian manuscripts of Capella and Calcidius, but the themes of eccentric and epicyclic motions presented the greatest challenges to ninth-century scholars and elicited the most remarkable activity in astronomical diagrams.

The works of Capella and Calcidius, although known just as early as those of Pliny and Macrobius, seem not to have been used until later for astronomical study and teaching. Martianus Capella's work, composed of an allegory plus a separate chapter, or "book," on each of the seven liberal arts, received at least three full commentaries in the ninth century. At the end of the century, Remigius of Auxerre wrote a commentary that was widely used for centuries thereafter.[18] At midcentury, John Scot Eriugena wrote a commentary showing his extensive use of known

[17]Diagrams for climatic zones and for the correspondence between celestial and terrestrial zones were prescribed by Macrobius and were excerpted and used by Carolingian teachers and scholars like Dungal at Pavia (ca. 825), Hadoard of Corbie (mid-ninth century), and an anonymous collection in a Bern ms. For these diagrams see, respectively, Berlin SB Phillipps 1784, ff. 4r, 7v; Vat. Regin. lat. 1762, ff. 195r, 198v; Bern Burgerbibliothek 347, ff. 17v, 20r; all three mss. are ninth century.

[18]Remigius Autissiodorensis, *Commentum in Martianum Capellam*, 2 vols., ed. Cora Lutz (Leiden: Brill, 1962-65).

astronomical sources.[19] And prior to Eriugena, perhaps as early as the middle 830s, a large anonymous commentary was composed at an unknown center (in north-eastern France) with rich resources.[20] The astronomical part of this commentary on Capella contains diagrams in most of the ninth-century manuscripts, and in one of the earliest, containing the largest number of diagrams, there was compiled a group of ten instructive diagrams for the astronomy book. These appear at the end of Capella's work, after the ninth book, on music. There are likewise groups of diagrams located at the end of Book Nine for the other mathematical books as well. The astronomical diagrams deal solely with the planets and cover a range of topics from the elementary to the complex and exploratory level. They were so well known and approved that they came to be attached later to copies of the commentary by Remigius of Auxerre. The most elaborate and widely copied of the ten diagrams was a combined trio of choices for the pattern of the planets Mercury and Venus in paths around the Sun.[21] Here in the planetary diagrams designed to accompany a Carolingian commentary on Capella we find a crucial example of the importance of diagrams for understanding and teaching planetary astronomy. These diagrams, which were committed to permanence in ink on parchment, are not necessarily all that were used in the teaching of Capellan astronomy. It was Martianus Capella himself who reminded his readers of the use of temporary drawings in fine powder on flat boards (inscribing on wax tablets was also available) for many mathematical problems.[22] Without such diagrams Capella's astronomical book would not have been as readily accessible to students. We should think of the creation of diagrams in tandem with the creation of explanatory comments, for both are essential parts of instruction in this discipline.

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[19]Johannes Scottus, *Annotationes in Marcianum*, ed. Cora Lutz (Cambridge, Mass.: Mediaeval Academy of America, 1939). For his use of astronomical sources, see Eastwood, "Eriugena and Astronomy," ref. n. 9.

[20]The parts of this commentary on music have been critically studied and edited by Mariken Teeuwen, *Harmony and the Music of the Spheres: the* ars musica *in Ninth-Century Commentaries on Martianus Capella* (Leiden: Brill, 2002). Teeuwen notes another ninth-century set of glosses, the Cambridge glosses, which we do not consider, because they are of minor importance for astronomy. Bruce Eastwood has studied and is preparing an edition of the astronomical part of the anonymous commentary. One exemplary ms. of the astronomical commentary in this anonymous work is in Leiden UB ms. Voss. lat. F.48, written at or a few years before the middle of the ninth century.

[21]The appendix of ten planetary diagrams accompanying the anonymous commentary is described in the preliminary study by Bruce Eastwood, "Astronomical Images and Planetary Theory in Carolingian Studies of Martianus Capella," *Journal for the History of Astronomy*, 31 (2000), 1-28, esp. 9-11. The widespread use of the trio of diagrams for circumsolar planets is discussed in ibid., pp. 12-21, and in idem, "The Chaster Path of Venus *(orbis Veneris castior)* in the Astronomy of Martianus Capella," *Archives internationales d'histoire des sciences*, 32 (1982), 145-58.

[22]See n. 14 for Capella's statement as well as others.

In the diagrams accompanying Capella and in those used by Calcidius there are important examples of theoretical inquiry and the construction and reconstruction of models of planetary motion. Referring again to the Capellan diagrams for circumsolar Mercury and Venus, we can find that the diagrams present three distinctly different patterns; each sharpens notably the meaning of the verbal text of Capella. Furthermore these diagrams build on both the main text and the text of the verbal (anonymous) commentary. What has occurred in this case is an inquiry into the meaning of the text by the commentator and the designer of the three diagrams for Sun-centered Mercury and Venus. The text of Capella clearly intended a single pattern, but some ambiguity in vocabulary emerged, and sufficiently precise details were absent. The diagrams provided the full recognition and response to this situation by proposing three possible models for the three planets involved and attaching the names of known authorities, including Capella, to them.

In the text of Calcidius, diagrams were already present, but they were not always clear and correct for their Carolingian readers. While we have indirect evidence that a copy of Calcidius' *Commentary on the Timaeus* was at Charlemagne's court, the earliest evidence of the text's use for astronomy is in a midcentury astronomical compendium, and the earliest example of active concern with its astronomical diagrams appears in the late ninth century.[23] The astronomical portion of Calcidius' commentary is not the longest part, and its purpose is more correctly characterized as cosmological than astronomical. Calcidius aimed to show that the late ancient astronomy of his own time (fourth century) and the cosmology of Plato, stated eight centuries earlier, were fully commensurate.[24] This philosophical goal dictated, or at least allowed, an essentially qualitative rather than quantitative approach to astronomical propositions and models. Because the techniques of the eccentric and the epicycle were such well-known and widely used tools in the

[23]The midcentury astronomical compendium is described by Bruce Eastwood, "Calcidius's Commentary on Plato's *Timaeus* in Latin Astronomy of the Ninth to Eleventh Centuries," in L. Nauta and A. Vanderjagt, ed., *Between Demonstration and Imagination. Essays in the History of Science and Philosophy Presented to John D. North* (Leiden: Brill, 1999), pp. 171-210, at 172-8. The late-ninth-century ms. is perhaps the earliest extant copy of Calcidius's commentary and is discussed by Rosamond McKitterick, "Knowledge of Plato's *Timaeus* in the Ninth Century: the Implications of Valenciennes, Bibliothèque Municipale MS 293," in H. Westra, ed., *From Athens to Chartres: Neoplatonism and Medieval Thought. Studies in Honour of Edouard Jeauneau* (Leiden: Brill, 1992), pp. 85-95.

[24]Calcidius set out two sections, "On the fixed stars and the planets" and "On the heavens [and on time]," which modern editions have divided into a total of 63 paragraphs (cc. 56-118). While many of the paragraphs are routine astronomical propositions, e.g., that the earth is at the center of the celestial sphere (c. 59), there are many strictly astronomical concerns omitted. See the critical edition of J. H. Waszink, *Timaeus a Calcidio translatus commentarioque instructus* (London: Warburg Institute, 1962/1975).

planetary astronomy of Ptolemy and his successors, producing uniformity where the phenomena seemed nonuniform, Calcidius devoted a great deal of attention to these two devices and the models of which they were part. The mid-ninth-century compendium that is our first evidence of Carolingian use of Calcidius already drew lengthy excerpts employing a model with an eccentric to explain the variations in the lengths of the four seasons of the year. This Calcidian model is a critical example of the new explanatory and geometrical approach in astronomy of the ninth century because the computistical tradition, for example, Bede and Rabanus Maurus, either deemphasized or ignored this problem and made no attempt to explain its cause. And in a manuscript that came originally from the cathedral of Reims we find a late-ninth-century correction and improvement of the relevant diagram in a copy of Calcidius's *Commentary*.[25] What we find being worked out in the diagrams of this proposition (cc. 79-80) are the questions of late Carolingian scholars as they read the text and attempted to make sense of the often-corrupt diagrams inherited from earlier centuries. In such work the Carolingians modified and tried to correct diagrams in order to provide understanding for their contemporaries and especially for students. There appears every likelihood that the frequency of corruption in the tradition of diagrams for a solar eccentric to explain the seasons led to the use of alternatives that were worked out on the powder boards and wax tablets of the schools. The small number of students advancing to the level at which this problem might be addressed must have found themselves in active dialogue and diagramming with their teachers. The planetary diagrams of Calcidius's *Commentary* were the most challenging and informative of those that appeared in the Carolingian courts, monasteries, and schools. They came into use only in the last part of the ninth century and provided problems and answers for subsequent generations of students of the liberal art of astronomy through the tenth and eleventh centuries.

Beyond the eleventh century, each of these four Roman sources had its own history. The work of Macrobius survives in over 100 manuscripts from the twelfth century alone, a time when it was mined primarily for Platonist doctrines and for its teachings on dreams, the meanings of fables, the soul, and much cosmological information. In the thirteenth century John of Sacrobosco used Macrobius's *Commentary* for many definitions in his *Treatise on the Sphere*, the most widely used textbook on basic astronomy during the later Middle Ages, and the *Commentary* remained an important source of Platonic doctrines and cosmology through the

[25] Valenciennes BM ms. 293, f. 48v. The ms. was given to the monastery of St. Amand by Hucbald (d. 930). See McKitterick, "Knowledge of Plato," p. 90 (above, n. 23).

Renaissance.[26] Pliny's *Natural History* actually saw much more copying in the fifteenth and sixteenth centuries than in the Middle Ages. However, the lengthy astronomical excerpts from Pliny with diagrams added in the Carolingian computistical compilations continued to be used in introductory textbooks of cosmology in the twelfth and later centuries as shown by the dates of a large number of manuscripts.[27] Calcidius's *Commentary* saw its widest use as a basis for study of the *Timaeus* before the twelfth century, when manuscripts of his translation of Plato's *Timaeus* multiplied rapidly while the number of new copies of Calcidius's commentary declined.[28] Nonetheless individual doctrines in that commentary continued to cast influence, for example, Calcidius's rendering of epicyclic planetary motion, which appeared in Sacrobosco's *Sphere* with the signature error of determining stationary points by drawing tangents from the center of the earth to the epicycle.[29] Of the four Roman works we have seen dominating Carolingian planetary astronomy, it was Martianus Capella's that remained an authority in astronomy for the longest time. Through the eleventh and twelfth centuries and at the University of Paris until approximately the middle of the thirteenth century, Capella's Book VIII, on astronomy, was a standard textbook for students.[30] Capella's work received renewed interest during the Renaissance, especially because of the mythological and religious contents in Books I-II, and copies made during the fifteenth century preserved the astronomical diagrams added during the Carolingian era.

[26] Albrecht Hüttig, *Macrobius im Mittelalter. Ein Beitrag zur Rezeptionsgeschichte der Commentarii in Somnium Scipionis* (Frankfurt: Lang, 1990), 167-170 et passim.

[27] A twelfth-century example of the use of versions of the Plinian diagrams for apsides and latitudes, inserted into Bede's *De natura rerum*, appears in Baltimore Walters Art Gallery ms. W.73, f. 5r-v; see Harry Bober, "An Illustrated Medieval School-book of Bede's 'De Natura Rerum,'" *Journal of the Walters Art Gallery*, 19-20 (1956-57), 64-97. For Renaissance use and commentary on Pliny see Charles G. Nauert, Jr., "Caius Plinius Secundus," *Catalogus translationum et commentariorum*, 4 (1980), 297-422. Arno Borst, *Das Buch der Naturgeschichte. Plinius und seine Leser im Zeitalter des Pergaments* (Heidelberg: Winter, 1994), pursues a wide variety of topics with enthusiasm and occasional extravagance.

[28] Paul E. Dutton, "Medieval Approaches to Calcidius," in *Plato's "Timaeus" as Cultural Icon*, ed. Gretchen J. Reydams-Schils (Notre Dame: University of Notre Dame Press, 2003), 183-205.

[29] See Calcidius, Commentarius 85: see ed. Waszink, pp. 136-137; Olaf Pedersen, "In Quest of Sacrobosco," *Journal for the History of Astronomy*, 16 (1985), 175-221, at 211.

[30] Bruce Eastwood, "Invention and Reform in Latin Planetary Astronomy," in *Latin Culture in the Eleventh Century. Proceedings of the Third International Conference on Medieval Latin Studies, Cambridge, September 9-12 1998*, ed. Michael Herren et al. (Turnhout: Brepols, 2002), I, 264-297, at 268-282; idem and Gerd Graßhoff, "Planetary Diagrams — Descriptions, Models, Theories: From Carolingian Deployments to Copernican Debates," in *The Power of Images in Early Modern Science*, ed. Wolfgang Lefevre et al. (Basel: Birkhäuser, 2003), pp. 197-226, at 214-15.

2 FUNCTIONS AND LOCATIONS OF PLANETARY DIAGRAMS

Initially we can say that a diagram might illustrate, clarify, or explain the text with which it is associated. An example of an illustrative diagram is the Plinian diagram for planetary order included with the excerpt in the textual space in many early manuscripts of the excerpt. The radial sequence of planets is given in the verbal excerpt and repeated in the diagram of concentric circles. No essential information is added for understanding the specific order represented. The circularity of the orbits is already explicit in the text, while the orbital time, also in the text, is excluded from the image. The concentric arrangement and the equal spacing of the circles are pedagogical additions in the diagram; they make the order easiest to perceive and make obvious the character of planetary intervals, which appear in the succeeding excerpt and diagram. The diagram for planetary order is carefully designed to illustrate only one attribute, the order of the planets. The same is true of the diagram for planetary intervals.

Clarification occurs in the Plinian diagram for apogees, in which the concentric circles are abandoned. There the actual eccentricity of the planetary orbits, according to Pliny, must be shown. The diagram for order of the planets, like that for intervals, simply illustrates one characteristic of planetary orbits. It does not add clarification of this trait or explain the trait (or others). The Plinian diagram for apogees adds clarity to the text since it shows the spatial relationship of earth, planet, and zodiacal sign under which the apogee occurs. The design makes clear the location of the center of each eccentric planetary circle under the proper zodiacal sign. This clarification involves the presentation of more information to complete the understanding of the list of zodiacal locations for the apogees of the several planets. In this diagram, as in those preceding it, there is only one essential topic for depiction, ignoring both of the topics previously illustrated.

Finally, the Plinian diagram for planetary latitudes includes a greater amount of information than any of the previous ones we have discussed. The latitude diagram explains in a significant way; it adds a theoretical method for presenting the data about latitudes that is in no way obvious or to be assumed by the student reader. The latitude diagram appears in two forms. The earlier, circular form sets the planetary circles at different amounts of eccentricity against a background of thirteen concentric circles representing the 12° of the zodiac. This design is a stereographic projection of the zodiacal band and of the planetary circles, which are inclined at varied angles to the central plane of the zodiacal band. The later, rectangular form of latitude diagram sets down a horizontal grid, commonly of twelve spaces vertically and thirty spaces horizontally. This grid represented the width of the zodiacal band of 12°. With the central horizontal line as the ecliptic,

each planet's latitude was represented by a sinusoidal wave along the grid, from left to right, with the number of degrees in latitude shown by the number of squares above and below the central horizontal line of the grid. Here again, as with the circular form, the abstraction of the zodiacal band to a rectangular grid, which had no precise horizontal value, either 360° or any other value, as the background for the planetary latitudes, required oral instruction for the student in order to create understanding. But the understanding, once gained, provided the student reader with a fuller explanation of the phenomenon of planetary latitude than a directly illustrative diagram, e.g., two lines at a designated angle to each other.

Illustration, clarification, and explanation are, as such, unproblematical functions of diagrams. The function is disturbed when a diagram is absent from a text and a blank space exists on the page, although a reader may seek the image in another copy of the text. The function is distorted when a diagram is corrupt in a manuscript, and further problems emerge, depending on the reader's awareness of the corrupt nature of the diagram and the reader's degree of understanding of the text and the topic concerned. The study of corrupt diagrams and the medieval attempts to improve or correct them is an important part of the history of medieval astronomy, but here we intend to focus on identifying the topics of the diagrams, whether correct or corrupt, leaving for other investigations the study of the processes of response to corrupt diagrams.[31]

Beyond the purpose of illustrating, clarifying, or explaining a text, a diagram may interrogate the text. When questioning or exploring a text, a diagram is always an addition, usually a marginal addition beside the relevant text, and the diagram, or diagrams, will bring out an ambiguity in the text. An example mentioned above is the trio of diagrams for circumsolar Mercury and Venus that was added to a number of Carolingian and later manuscripts of Martianus Capella's astronomy. In this case, the trio of diagrams proposed for the two circumsolar planets: (1) concentric circles, (2) intersecting circles, and (3) pendant and intersecting major arcs of circles (or even ovals) as alternative readings of the text.[32] Further details of this situation are provided below; here we want to emphasize the interrogative and exploratory function of diagrams. This function is not observed often, but its appearance is extremely important as one guide to independent and imaginative scrutiny of texts by medieval scholars.

To facilitate understanding and instruction, diagrams can appear in various locations in manuscripts. The locations for planetary diagrams in the four Roman

[31] For a study of the medieval correction of a corrupt diagram (in Calcidius) for Venus circling the Sun see Bruce Eastwood, "Heraclides and Heliocentrism: Texts, Diagrams, and Interpretations," *Journal for the History of Astronomy*, 23 (1992), 233-60.

[32] See n. 21 for studies on these diagrams in Capellan manuscripts.

texts are these: (1) in the special openings provided in the textual space between lines of text, (2) in the margins beside or near the relevant text, and (3) in a group of diagrams at the end of the text, analogous to endnotes in a modern scholarly study. The first location is used in copies of the Pliny excerpts, Macrobius's *Commentary*, and Calcidius's *Commentary*; this placement appears only after the Carolingian era in copies of Capella's *Marriage of Philology and Mercury*. We find placement of diagrams in the margins consistently in Capella's work, only occasionally and only in post-Carolingian times in the works of Macrobius and Calcidius, and not at all in the Plinian astronomical excerpts. Finally, the planetary diagrams appear at the end of the textbook only in the case of Martianus Capella, and this is inconsistent; often Capellan planetary diagrams appear only in the margins.

The significance of these different locations lies in their origins. Diagrams appearing in the textual space, normally in large spaces between lines of text, originate with the author of the text. Thus Calcidius and Macrobius specified and described diagrams, and these appear in the text where the description occurs. While Pliny himself specified no diagrams, the Carolingian excerptors of Pliny's work added the diagrams as part of the work of excerpting, a strong indication that the excerpts were meant primarily for education rather than original scientific investigation. Diagrams that appear in the margins are those added for explication of the text when no diagram is included by the original author. Marginal diagrams may also appear as corrections to diagrams in the text space; there are important examples in Calcidius's manuscripts. And marginal diagrams can appear as queries, innovations, or speculations with regard to a text. Thus we find marginal diagrams extensively in Capella's work, a major text for both teaching and new research—queries, innovations, speculations. There are also a few marginal diagrams in post-Carolingian copies of Macrobius's *Commentary*. Finally the placing of diagrams at the end of a text, like endnotes or an appendix, suggests a handbook for a teaching master. Capella's astronomical work is the sole example of this among our four Latin planetary sources. The early emergence of a set of ten Capellan diagrams at the end of the text, which became a very stable set, indicates a pedagogical intention at the beginning (before the mid-ninth century) and a continued teaching commitment to, or at least interest in, this appendix of ten standard diagrams.

3 SOURCES AND TOPICS OF PLANETARY DIAGRAMS

3.1 PLINY

Pliny's *Natural History*, the direct source of at least some and the ultimate source of many chapters of Bede's *On the Nature of Things* (ca. 701), received diagrams for four astronomical excerpts that appeared early in the ninth century. The separation

of these excerpts and their association with added diagrams occurred when the excerpts were chosen to accompany computistical materials in a collection that arose from a conference on computus in 809. The topics of the four Plinian excerpts that received diagrams were planetary order, intervals, apsides, and latitudes. The Latin texts, which the Carolingian excerptor(s) sometimes modified, as well as translations are provided in the chapter on the Plinian diagrams.

The four topics initially received circular diagrams, which all evolved to new forms, with only one of the new forms remaining circular. Furthermore, the second form of each diagram appeared within the ninth century, showing fairly rapid development in the use and revision of instructional diagrams. Planetary order first appeared as a set of labeled, equally spaced concentric circles, which then was replaced by a simpler, horizontal order of separate circles, each named for one of the seven planets.

Planetary intervals were first represented by a set of concentric, variably spaced circles. The radial interval between the earth and moon was the basic unit of length, a *tone*. Each planetary circle was labeled for the planet and each interplanetary space inscribed with the number of units (tones and semitones) between the enclosing planetary circles. This diagram was later changed to the simpler form of a vertical list of planetary names and intervals with no orbital circles at all.

The initial form of the third topic, planetary apsides, was a set of six eccentric circles. Apsides are the far and near points of planets on their eccentric circles with respect to the earth. The two opposing apsides are called *apogee* (far) and *perigee* (near). These Plinian apsides represented all the planets except the moon, and they were contained within a surrounding band of the twelve zodiacal signs. Each labeled planetary circle had its apogee (far point from the central earth) under the zodiacal sign to which Pliny had assigned it. There was no apogee for the moon because Pliny said its circle was concentric with the earth. The diagram for planetary apsides found a somewhat different second form, which was not universally adopted. This design omitted the names of all zodiacal signs having no planetary apogees since they were superfluous for this diagram and then rearranged the remaining six signs more evenly over the twelve 30° sections of the encircling zodiacal band. This produced a zodiacal band with the names of only six zodiacal signs, those having planetary apogees beneath them, and the six eccentric circles of the planets with apogees. The effect of this was, thus, to spread the apogees more evenly and obviously around the circular space of the diagram, making it easier to see which zodiacal sign had which planetary apogee.

Finally, the first form of diagram for the fourth topic displayed planetary latitudes as eccentric circles against a background of thirteen concentric, equally spaced circles; this pattern of twelve spaces, or bands, represented the 12° width,

or latitude, of the zodiac. A reader of this diagram needed to count the number of concentric circles between the lower and the upper extremities of the planet's eccentric circle in order to find the number of degrees of the planet's latitude in the zodiacal band. This cumbersome process was made obsolete rather soon by a new form of the diagram, a rectangular grid. The earliest form of this grid for planetary latitudes was a set of thirty one equally spaced vertical lines by thirteen equally spaced horizontal lines. The horizontal lines produced the twelve spaces to represent the 12° of the zodiac's width. At one end of the grid, usually the left, the seven planets were listed in vertical order and at the appropriate lines for their numbers of degrees in latitude. Each planet's latitude was then shown by a regular curve, reminiscent of a sine curve, between a high and a low point, on the zodiacal horizontal lines.

To obtain the number of degrees in a planet's latitude a reader needed only to count the spaces vertically in the first cycle of that planet's curve—much easier than the process in the first, circular form of latitude diagram. The rectangular form of latitude diagram became widespread and varied in its details but preserved the principle for determining the latitude. We must also notice that the horizontal component, or amplitude, of each of these planetary curves had no independent value of significance; its quantitative value in the better-formed examples of the diagram was directly proportional to the vertical component of the curve.

3.2 MACROBIUS

The use of the text and diagrams of Macrobius's *Commentary on the Dream of Scipio* began at about the same time as the earliest appearance of the Plinian planetary diagrams. From a well-known letter by the monk Dungal in 811, to which were subsequently appended excerpts and diagrams, we have evidence of the use of Macrobius.[33] The text of Macrobius is more cosmological than astronomical by modern standards, although it is not clear that such a view would have been advanced in the ninth century. Where we find the prescription for and description of a planetary diagram is in the chapter (I.xxi) in which Macrobius explained, first, what it means to say that a planet travels through the zodiac; second, what signs the planets were placed in at the creation of the world (according to the ancient Egyptians); and, finally, what order the planets hold (according to Plato and the Egyptians) between the earth and the stellar sphere. As the manuscript diagrams show, the presentation of the first and second points was in accord with the text

[33]See Bruce Eastwood, "The Astronomy of Macrobius in Carolingian Europe: Dungal's Letter of 811 to Charles the Great," *Early Medieval Europe*, 3 (1994), 117-34. Over 200 manuscripts of Macrobius's work are listed by idem, "Manuscripts of Macrobius, *Commentarii in somnium Scipionis,*" *Manuscripta*, 38 (1994), 138-55.

and relatively straightforward, but the diagrams for planetary order introduced an alternative sequence. We know that Dungal (in 811), prior to any substantial surviving manuscript of Macrobius's commentary, had manipulated the text of that work to support the planetary order of Pliny against that of Plato, which was supported by Macrobius. All early manuscripts of Macrobius's commentary that contain a planetary diagram at this point in the text follow Dungal in showing the order of Pliny, not Plato. In these cases the diagram for a planetary configuration shows the eight concentric bands, for the seven planets and the outer stars, with the seven planets placed in order under one zodiacal sign, normally Aries. The planetary order puts Mercury and Venus between the moon and the sun, contradicting Macrobius's text and agreeing with Pliny's *Natural History* and the Plinian astronomical excerpts and their diagrams. On the other hand, the order of Plato and Macrobius appears in later manuscripts in which the planets are spread out in the configuration to show each planet under a different zodiacal sign. Indeed, there are diagrams that combine these two different orders, the Plinian order under Aries and the Platonic order spread under seven signs.

Although the text of Macrobius prescribes only one planetary diagram, two others emerge in the manuscript tradition after the Carolingian era. As our description in the chapter on Macrobius explains, these two later diagrams are attached marginally to the section of the *Commentary* that compared the Platonic order with the alternative, for which Macrobius chose the Platonic as the correct order. Only in the eleventh and twelfth centuries did scholars add a diagram with intersecting circles, allowing Mercury and Venus to be alternately below and above the sun. And, it seems, only in response to this diagram with intersecting circles did some scholars of the late eleventh and twelfth centuries reaffirm the Platonic order alone in Macrobius's text by adding yet another diagram, with three or four concentric circles. Our list of diagrams and categories of diagram for Macrobius shows this.

3.3 CALCIDIUS

From the manuscripts of Calcidius' *Commentary on Plato's Timaeus* we present seven different topics for diagrams, some of which have variants, all of which relate to the use of eccentrics or epicycles in explaining the motions of the planets. No other Calcidian astronomical chapters or topics discussed these theoretical elements. Calcidius included many more topics, such as eclipses, but the seven topics investigated here, listed in the subheadings of the chapter on Calcidius, were especially significant and widely studied by way of Calcidius' commentary through the eleventh and twelfth centuries.

Plato's *Timaeus* was translated into Latin by Cicero and later by Calcidius. Both of these translations circulated in the ninth century, and the lengthy commentary

by Calcidius almost always accompanied his translation until the twelfth century, when the two were frequently disconnected. Calcidius' translation as well as his commentary are commonly found in two parts in the manuscripts, the first part containing the astronomy.[34]

Users of the modern critical edition by Waszink, the best to date, will find that the diagrams included in this edition are taken from one tenth-century manuscript.[35] The reproduction of those diagrams in the modern edition does not mean that they are correct or the best set of surviving diagrams. Studies have shown and will continue to show a great diversity of manuscript diagrams for the planetary doctrines reported by Calcidius.[36] However, some topics with diagrams show much more stability of imagery than others. Of the topics we cover, the one with the least variation in its diagrams is the description of the different lengths of the four seasons, since there is no attempt to explain the phenomenon in this text or image. The explanation with diagram comes in the subsequent paragraph, and here we find a remarkable history of attempts to comprehend and to reconstruct the diagram for this explanation, with a fully correct diagram appearing in the eleventh century. Calcidius' description of a generic epicycle has diagrams with little variation. Among the variations worth noticing in Calcidian diagrams, which we record in the relevant chapter, is the location of the diagram with respect to the text it illustrates. Virtually all Calcidian diagrams are in the textual spaces, not in the margins, of the manuscripts.

3.4 MARTIANUS CAPELLA

Capella's *The Marriage of Philology and Mercury* prescribed no diagrams for any of its four mathematical books. While there appeared occasional and infrequent marginal diagrams regarding the stars in the manuscripts of Book VIII, on astronomy, it was planetary topics that stimulated the most notable and lengthy traditions of diagrams, beginning well before the mid-ninth century and continuing through

[34]The circulation of Cicero's translation and of both the translation and commentary by Calcidius is discussed by Anna Somfai, "The Transmission and Reception of Plato's *Timaeus* and Calcidius's *Commentary* During the Carolingian Renaissance," Ph.D. dissertation, University of Cambridge, 1998. The manuscripts of both Calcidius's translation and his commentary, with indications of which parts are present in each manuscript, are listed by the editor, J. H. Waszink, *Timaeus a Calcidio*, pp. cvii-cxxxi, clxxxvii-clxxxviii.

[35]Waszink ed., *Timaeus a Calcidio*, p. clxxx.

[36]This is shown for the diagrams concerned with the bounded elongation of Venus by Eastwood, "Heraclides and Heliocentrism" (above, n. 26), and for the diagrams concerned with a solar eccentric to explain the seasons by idem, "Invention and Reform in Latin Planetary Astronomy," in *Latin Culture in the Eleventh Century. Proceedings of the Third International Conference on Medieval Latin Studies, Cambridge, September 9-12 1998*, ed. M. W. Herren et al., Publications of the Journal of Medieval Latin, vol. 5, pt. 1 (Turnhout: Brepols, 2002), pp. 264 -97, esp. 282-90.

the fifteenth.[37] The diagrams in the manuscripts are usually marginal; only in a few later, deluxe manuscripts do we find planetary diagrams inserted into the textual space. The topic that has the most frequent marginal diagrams in the ninth century is the circumsolar orbits of Mercury and Venus, and this frequency derives from the ambiguity of Capella's text. At two different points the manuscripts seem to prescribe incompatible patterns for the circumsolar planets, and the diagrams make this very clear. Although some early manuscripts with diagrams have obviously not survived, we have enough to conclude that a group of ten marginal diagrams was brought together before ca. 850 and placed at the end of the text as an appendix of planetary diagrams to be kept together. Some from this appendix were retained as marginal diagrams, usually with extended commentary attached to each of them. The appendix continued as a successful addition to Capella's astronomy and is found in a number of manuscripts having no other astronomical diagrams. There are also in certain Capellan manuscripts a few marginal planetary diagrams that are not part of the appendix, but it is remarkable how consistently topics for diagrams remained those of the appendix after the ninth century.

4 USING THIS WORK

This work is a description, explanation, and catalogue of medieval Latin planetary diagrams, with identification of their later manuscript appearances through the fifteenth century. For each of the four Roman authors, a reader will find not only descriptions of specific types of diagram, but also discussion of variants and corruptions as well as suggested reasons for some of these. While the precise texts the diagrams illustrated are obvious in the cases of Pliny and Calcidius, the cases of Macrobius and Martianus Capella present problems of interpretation at certain points. We have provided text, translation (usually new translation), and our own description for each diagram. In situations requiring interpretation we have offered comments about our interpretations or at least reasons for our interpretations. The selected illustrations from manuscripts are usually typical, although they are definitely not models that represent all examples. At some points we foung it appropriate to include untypical illustrations. This work provides identifications and classifications as well as descriptions of every type of planetary diagram originating before or in the twelfth century and used in conjunction with one or more of the four authors. Each of the traditions of the diagrams that we present begins in early medieval, mostly Carolingian, Latin manuscripts of the four classical Latin authors.

[37] The manuscripts of Martianus Capella have been thoroughly catalogued by Claudio Leonardi, "I Codici di Marziano Capella," *Aevum*, 33 (1959), 443-89; 34 (1960), 1-99, 411-524.

This work will at times be used for the catalogues of manuscript diagrams. They appear at the ends of the major parts of the work dealing with the four authors. Each of our catalogues of manuscripts, arranged alphabetically by city of the library holding or owning each manuscript, lists the exact page/folio for the location of a diagram. The catalogue of manuscript pages offers a date by century, sometimes by part of the century, according to either library catalogues or more modern studies of individual manuscripts. These dates are intended to aid but not to limit scholars who use our work. As experienced students of medieval manuscripts know, the dating of many a manuscript, when lacking precise internal evidence for a date, is difficult and almost always open for revision.

In each catalogue of manuscripts with page or folio numbers, the left-hand column provides an index key to use in associating the manuscript with a diagram. Thus a key like Plin25 will identify MS Arundel 339, folio 153r, of the thirteenth century, in our first list. The same key Plin25 appears in the second list, our catalogue of diagram types, to identify a type of Plinian apsidal diagram, with the type described in detail in the relevant prior section.

The second catalogue, or list, for each author is organized by types of diagram. A reader can easily see the number and relative frequency of each type of diagram. For certain authors, especially Capella, there may be more than one entry for a single manuscript page. For example, in the case of Cap42, which indicates folio 143r of a particular Venice manuscript, there are eleven diagrams, and these are noted by the appearance of "Cap42" in conjunction with eleven different types of diagram in the second catalogue for Capella. We have, in addition, provided the context for the appearance of a diagram in each manuscript. The right-hand column of the second list offers a brief notice. Thus Plin25 refers to a diagram appearing in a manuscript of astronomical and mathematical materials along with Macrobius' *Commentary on Scipio's Dream*. If a reader wishes to study all diagrams of Plinian apsides with a reordered zodiac, these are conveniently grouped together, and their index keys allow ready identification of the manuscripts and pages where they exist. For Macrobius and Capella the reader will find additional guides to variations in the diagrams at the head of each list of diagrams. In these two cases we use abbreviated keys to allow economical incorporation of more information about the diagrams. For Pliny and Calcidius we do not use this approach because the variations are fewer or apparently insignificant or more difficult to characterize usefully. The reader should always refer to the description of each type of diagram when consulting the catalogue of diagrams for the examples of a type. Our descriptions will help a reader use the lists of diagrams most effectively. Although we consider the lists of manuscripts with relevant diagrams to be full and representative of the relative quantity and the variety of Roman planetary diagrams

in the Middle Ages, we do not claim complete coverage. Whenever we have missed examples that should be included, we shall be extremely grateful for information about such items.

Chapter II

PLINIAN DIAGRAMS

1 Planetary Order Diagram

1.1 Description

Diagram for Planetary Order—Cirular

The Plinian diagram for planetary order is extremely simple (Fig. II.1). It contains either seven or eight concentric circles, equally spaced. In Plinian/Ptolemaic order (Saturn, Jupiter, Mars, Sun, Venus, Mercury, Moon) the seven planetary names are written in a vertical list, one name on each circle. When an eighth circle appears in the middle, it has a label for Earth. In any case, the label for Earth appears at the center of the diagram.

Diagram for Planetary Order—List

The Plinian diagram for planetary order that appears as a list (Fig. II.2) most commonly takes the form of seven small circles placed close together horizontally. Below each circle, from left to right, a planetary name appears from Saturn to Moon, in Plinian/Ptolemaic order (Saturn, Jupiter, Mars, Sun, Venus, Mercury, Moon). The Earth is not represented. Variations are common in this diagram.

1.2 Text and Translation

DE POSITIONE ET CURSU SEPTEM PLANETARUM. Inter caelum et terram certis discreta spatiis septum sidera pendent quae ab incessu vocamus errantia, cum errent nulla minus illis. Quorum summum saturni sidus ideoque minimum videri et maximo ambire (ed. King: abire) circulo, ac trecesimo anno ad brevissima sedis suae principia regredi certum est. Inde inferiorem iovis circulum et ideo motu celeriorem duodenis circumagi annis. Tertium martis sidus igne ardens solis vicinitate binis fere annis converti. Tum solis meatum esse partium quidem CCCLX, sed ut observatio umbrarum eius redeat ad notas, quinos annis dies adici superque quartam partem diei, quam ob causam quinto anno unus intercalarius dies additur ut temporum ratio solis itineri congruat. Infra solem ambit ingens sidus appellatum veneris, alterno meatu vagum; signiferi circuitum peragit trecentis et duoquinquagenis diebus, a sole numquam absistens partibus sex atque XL longius. Simili ratione, sed nequaquam magnitudine aut vi, proximum illi mercurii sidus inferiore circulo fertur novem diebus otiore ambitu, modo ante solis exortum

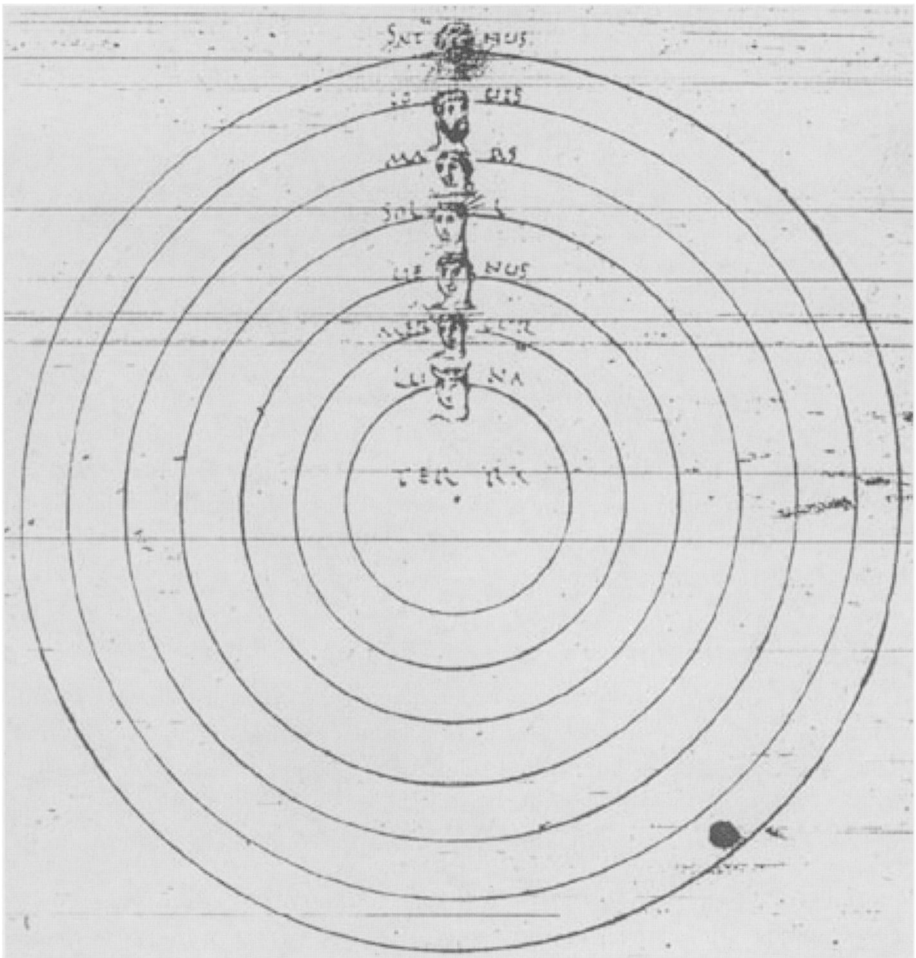

Figure II.1. Planetary order—circular. Monza Biblioteca Capitolare, Ms. F.9.176, f.70v. Reproduced with permission of the Biblioteca del Duomo di Monza.

modo post occasum splendens, numquam ab eo XX duabus partibus remotior. Ideo et peculiaris horum siderum ratio est neque communis cum supra dictis. Nam eae et quarta parte caeli a sole abesse et tertia, et adversa soli saepe cernuntur. Sed omnium admirationem vincit novissimum sidus terris familiarissimum lunae, crescens semper aut senescens, modo curvata in cornua facie, modo aequa portione divisa, modo sinuata in orbem, maculosa eademque subito praenitens,

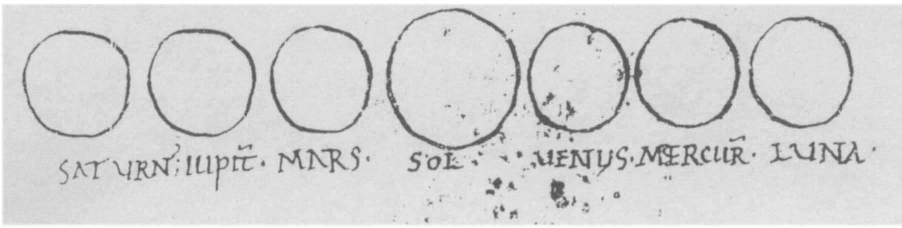

Figure II.2. Planetary order—list. Zürich Zentralbibliothek, Ms. Car.C 122, f.39v. Reproduced with permission.

inmensa orbe pleno ac repente nulla, alias pernox alias sera et parte diei solis lucem adiuvans, deficiens et in defectu tamen conspicua, iam vero humilis et excelsa, et ne id quidem uno modo, sed alias admota caelo alis contigua montibus, nunc in aquilonem elata nunc in austros deiecta; proxima ergo cardini ideoque minimo ambitu, vicenis diebus septenisque et tertia diei parte peragit spatia eadem quae saturni sidus altissimum XXX ut dictum est annis. Dein morata in coitu solis biduo cum tardissime a tricesima luce ad easdem vices exit.[1]

Suspended between the heavens and the Earth at definite spacings are the seven stars which we call the wanderers (planets) from their motion, yet none wanders less than these. Saturn is the highest of these and therefore looks the smallest and revolves in the largest circle and in thirty years at the least returns to its starting point. Jupiter's circle is below and therefore faster in motion, revolving in twelve years. Third is Mars glowing like fire because of the proximity of the Sun and completing its orbit in about two years.

Then the course of the Sun is divided into 360 parts, but five and one-fourth days are added yearly in order for observation of the shadows of the Sun [with a sundial] to return to the initial position; and so an intercalary day is added every fourth year for the calculation of the seasons to coincide with the course of the Sun. Below the Sun travels the huge planet called Venus, which shifts its course back and forth; it passes through the whole zodiac in 348 days, never extending more than 46° from the Sun. Next to it in the circle below is Mercury, with a similar pattern but not as much size or power, which orbits in nine days less, sometimes rising before the Sun, sometimes shining after sunset, and never withdrawing more than 22° from it. Therefore the pattern of these [two] planets is distinctive and not

[1] Plinius (1888), pp. 34-6.

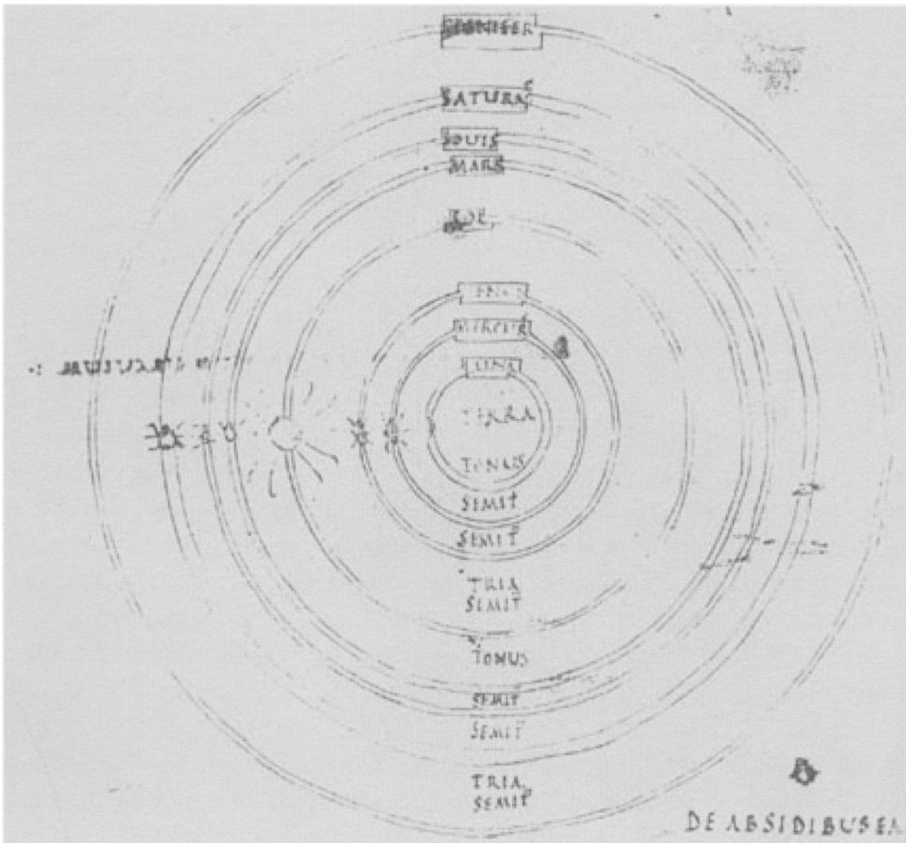

Figure II.3. Planetary intervals—circular. London British Library, Ms. Harl. 647, f.19r. By permission of the British Library.

like those [upper planets] previously mentioned, for those are often found one-fourth or one-third of the zodiac away or even in opposition to the Sun. But the last planet, the Moon, which is the most familiar to the Earth, overwhelms the admiration of everyone with its constant waxing and waning, sometimes horned, sometimes halved, sometimes turned into full orb. It will be spotted and then suddenly shine clear, huge and fully rounded and then quite absent, now visible throughout the night, other times only late at night and into the daytime to add to the Sun's light. When eclipsed it is still visible during the eclipse. It is both low and high [in the heavens] and not in one way only; it is at times raised high in the

sky and other times touches the mountains, now high in the north, again low in the south. Therefore it is nearest [of the planets] to the axis [and center] of the cosmos. And so with the shortest circuit it travels in 27-1/3 days the same space as Saturn, the highest planet, does in 30 years, as we have said, and then stays two days in conjunction with the Sun and on the thirtieth day at the latest sets out on the same [orbital] path.[2]

2 PLANETARY INTERVALS DIAGRAM

2.1 DESCRIPTION

Planetary Intervals—Circular

The planetary intervals are considered harmonic intervals, although Pliny also equates them with measured distances. These intervals are multiples of the distance from the Earth to the Moon. The Plinian circular diagram for planetary intervals (Fig. II.3) contains eight concentric circles, spaced at unequal radial distances. The diagram always has a label for the Earth at a point or spot or disc at the center. The outermost circle is labeled generically for the zodiac. Each circle within is labeled from top down to the center with the names of the planets in Plinian/Ptolemaic order. From the center of the diagram downward to the zodiacal circle, each circle is labeled with a harmonic interval to provide its interval from the next circle within (or central point, in the case of the Earth—Moon interval). The Plinian excerpt gives these intervals as follows:

Earth—Moon	whole tone
Moon—Mercury	half tone
Mercury—Venus	half tone
Venus—Sun	three half tones
Sun—Mars	whole tone
Mars—Jupiter	half tone
Jupiter—Saturn	half tone
Saturn—Zodiac	three half tones

In accord with the relative sizes of the numbers in these intervals, the diagram sets the eight concentric circles at different radial distances apart. Very often the diagram will show, in addition to all the elements above, small symbols or representations of the planets, arranged either horizontally or vertically on the respective circles.

[2] Our translation.

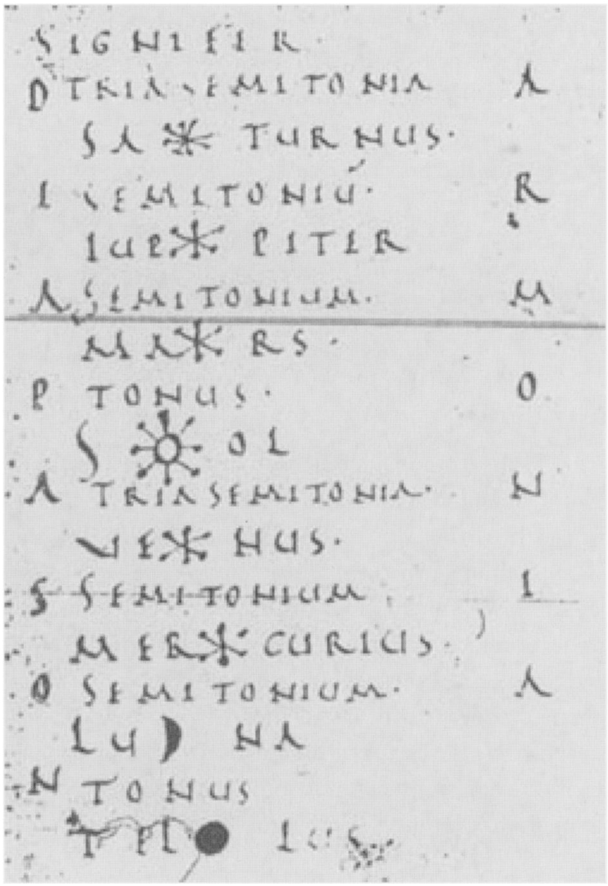

Figure II.4. Planetary intervals—list. Oxford Bodleian Library, Ms. Canon. Class. lat. 279, f.33r. With permission of the Bodleian Library, University of Oxford.

Planetary Intervals—List

The Plinian list of planetary intervals (Fig. II.4) takes the form of a vertical list of zodiac, planets, and Earth, named in Plinian/Ptolemaic order. The Plinian harmonic interval between each pair of planets (including zodiac and Earth at the two extremes of the list) is named in its place between the two respective planets vertically. The planetary harmonic intervals provided in the Plinian excerpt are as follows:

Earth—Moon	whole tone
Moon—Mercury	half tone
Mercury—Venus	half tone
Venus—Sun	three half tones
Sun—Mars	whole tone
Mars—Jupiter	half tone
Jupiter—Saturn	half tone
Saturn—Zodiac	three half tones

Infrequently this list appears horizontally rather than vertically. Only when combined with the rectangular latitude diagram as a horizontal list below the grid does the intervals list consistently appear with this orientation.

2.2 TEXT AND TRANSLATION

DE INTERVALLIS EARUM. Intervalla eorum a terra multi indagare temptarunt, et solem abesse a luna undeviginti partes quantum lunam ipsam a terra prodiderunt. Sed phitagoras vir sagacis animi a terra ad lunam CXXV stadiorum collegit, ad solem ab ea duplum, inde ad XII signa triplicatum. Interdum et musica ratione appellat tonum quantum absit a terra luna, ab ea ad mercurium dimidium spatii, hoc est semitonium, et ab eo ad venerem tantundem, a quo ad solem sescuplum, id est tria semitonia, a sole ad martem tonum, id est quantum ad lunam a terra, ab eo ad iovem dimidium, et ab eo ad saturnum tantundem spatii, inde ad signiferum sescuplum. Ita septem tonis effici quam diapason armoniam vocant.[3]

Many have tried to discover the intervals of these [planets] from the Earth, and they have proposed that from the Sun to the Moon is nineteen times as far as from the Earth to the Moon. But Pythagoras, a man of very acute mind, concluded that from the Earth to the Moon is 125,000 stadia, and double that from the Moon to the Sun, and three times that [from the Sun] to the zodiacal signs. And sometimes following musical theory he calls a tone that amount from the Earth to the Moon. From there to Mercury half the space, which is a semitone, and the same [a semitone] from there to Venus, from which to the Sun is one-and-one-half, which is three semitones; from the Sun to Mars is a tone (as much as from the Earth to the Moon) and from there to Jupiter a half, and from Jupiter to Saturn the same amount of space. From there to the zodiac is one-and-one-half. Thus are produced the seven tones that they call the musical diapason, or octave.[4]

[3] Plinius (1888), pp. 36-7.
[4] Our translation.

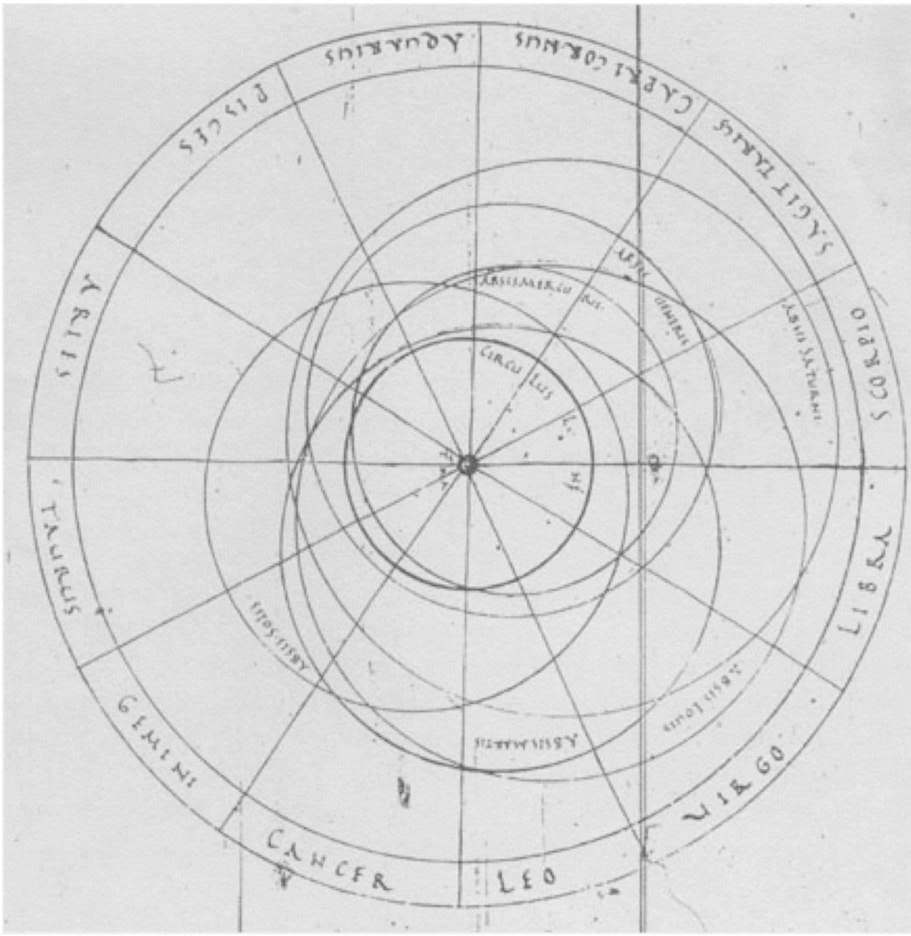

Figure II.5. Absides—normal zodiac. Oxford Bodleian Library, Ms. Canon. Class. lat. 279, f.33v. With permission of the Bodleian Library, University of Oxford.

3 ABSIDES DIAGRAM

3.1 DESCRIPTION

Plinian Absides—Normal Order

The absides are the near and far points, or perigee and apogee, of each planet with respect to the Earth. Eccentric circles are the means to indicate their locations. A

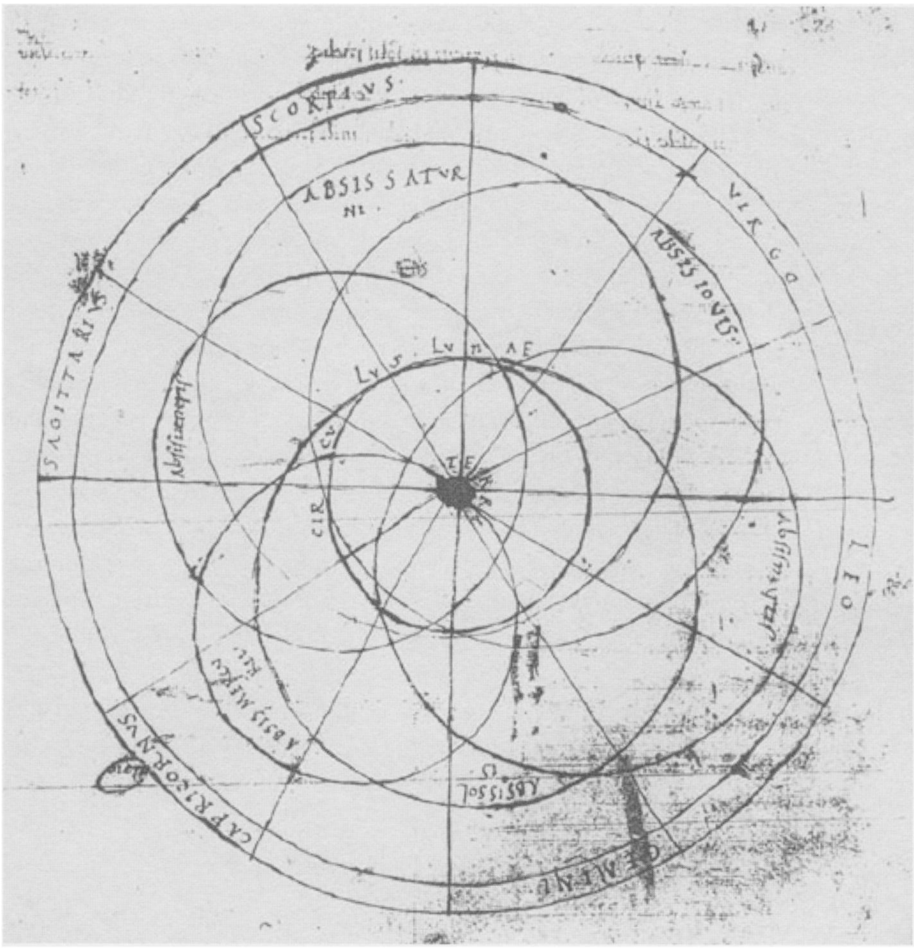

Figure II.6. Absides—rearranged zodiac. München Bayrische Staatsbibliothek, clm 14436, f.60v. Reproduced with permission of the Bayerische Staatsbibliothek.

diagram (Fig. II.5) for planetary absides is the only planetary diagram explicitly mentioned in the Plinian astronomical excerpts. The diagram is only partly described in the excerpt. This mention of a diagram is a medieval addition that does not appear at all in the original text of Pliny's *Natural History.* The Plinian diagram for planetary absides has two forms, one with a normal, or natural, order of the zodiacal signs and one with an artificial, or rearranged, order of the zodiacal signs. The diagrams for both have the same graphical form. This form, or framework,

consists of an outer circular band with twelve equally spaced radial lines dividing both the outer band and the contained space into twelve equal parts. A small circle appears at the center of the diagram. In the normal-order diagram for absides, the names of the twelve signs are placed in their natural sequence in counterclockwise direction in the twelve sections of the outer band. It is of no consequence where Aries 0° is placed in this diagram, and different diagrams may place it differently. The small central circle will be labeled Moon or sometimes Earth. When it is labeled Moon, the center of the diagram usually has the label for Earth. When the central circle is labeled Earth, there is a separate, concentric circle enclosing it for the Moon. For each of the six planets other than the Moon, there is an eccentric circle in the space between the lunar circle and the zodiacal band. Each eccentric circle has a label naming its planet. Each circle is drawn so that its apogee, or point of maximum distance from the central Earth, falls within the angular section below the zodiacal sign assigned to the planet. The absides, or eccentric circles, show the locations in the zodiac according to Pliny for the farthest distances of the planets from the Earth; at the apogee a planet will appear to be traveling slowest during its full orbit. The near points, or perigees, which are points of swiftest apparent travel, are diametrically opposed to the far points. In the diagram for absides the name of the planet does not always appear under the zodiacal sign for its apogee. It is always necessary to ascertain where the geometrical apogee for each circle is located. Pliny lists the zodiacal signs for apogees; he does not name the signs for perigees. His list assigns the planets to the signs as follows:

Saturn in Scorpius
Jupiter in Virgo
Mars in Leo
Sun in Gemini
Venus in Sagittarius
Mercury in Capricorn

The excerpt assigns no absis to the Moon. Because of a medieval emendation, assigning an absis to the Moon in Taurus, in some manuscripts of the full text of *Pliny's Natural History* some absidal diagrams show such an arrangement for the Moon, but this is neither standard nor frequent.

Plinian Absides—Rearranged Zodiac

The Plinian diagram for planetary absides with rearranged zodiac (Fig. II.6) has the same graphical framework as that for the absidal diagram with normal order. (See the description for the normal-order diagram of absides.) The differences between

the two types of absidal diagram are the number and placement of the zodiacal signs. The primary difference is the omission of the names of all zodiacal signs that contain no planetary apogee. There is no change in the graphical structure, so that twelve spaces remain for names of signs. The second difference is the rearrangement of the names of the six signs for apogees in these twelve spaces, which requires a coincident rearrangement of the six eccentric planetary circles. The resulting diagram for apogees spreads the six names of signs more fully and in more balanced form around the full circle of the zodiacal band. Usually, but not always, the six signs will be placed evenly around the band, one name in every other space. The reordered zodiac has only one purpose to exist in place of the normal zodiac: to make the zodiacal location of planetary apogees more easily observed. The apogees for the six planets remain, of course, the same as in the normal-order diagram: Saturn in Scorpius, Jupiter in Virgo, Mars in Leo, Sun in Gemini, Venus in Sagittarius, Mercury in Capricorn.

3.2 TEXT AND TRANSLATION

DE ABSIDIBUS EARUM. Tres autem quas supra solem diximus sitas occultantur meantes cum eo, exoriuntur vero matutino discedente sole partibus numquam amplius undenis; postea radiorum eius contactu reguntur et in triquetro a partibus CXX stationes matutinas faciunt, quae et primae vocantur, mox in adverso a partibus CLXXX exortus vespertinos, iterumque in CXX partibus ab alio latere adpropinquantes stationes vespertinas quas et secundas vocant, donec adsecutus sol in partibus duodenis occultet illas qui vespertini occasus appellantur. Martis stella propius etiam ex quadrato sentit radios, a XC partibus ab utroque exortu; eadem stationalis senis mensibus moratur in signis, alioqui bimenstris, cum ceterae utraque statione quaternos menses non impleant. Inferiores autem duae occultuantur in coitu vespertino simili modo, relictaeque a sole totidem in partibus faciunt exortus matutinos, ad quos longissimis distantiae suae metis solem insecuntur, adeptaeque occasu matutino conduntur ac praetereunt; mox eodem intervallo vespere exoriuntur usque ad quos diximus terminos; ab his retrogradiuntur ad solem et occasu vespertino delitiscunt. Veneris stella stationes duas matutinam vespertinamque ab utroque exortu facit a longissimis distantiae suae finibus. Mercurii stationes breviori momento quam ut depraehendi possint, cuius rei ratio privatim reddenda est. Percussae in qua diximus parte et triangulo solis radio inhibentur rectum agere cursum et ignea vi levantur in sublime. Hoc non protinus intellegi potest visu nostro ideoque existimantur stare, unde et nomen accepit statio. Praegreditur deinde eiusdem radii violentia et retroire cogit vapore percussas. Multo id magis in vespertino earum exortu, toto sole adverso cum in summas absidas expelluntur minimaeque cernuntur, quoniam altissimae absunt et minimo feruntur motu, tanto

minore cum hoc in altissimis absidum evenit signis. Absides autem dicuntur circuli earum greco vocabulo. Sunt autem hi sui cuique earum, aliique quam mundo, quoniam terra inter vertices duos quos appellaverunt polos, et signiferum centrum mundi esse videtur, ideoque unam quamque absidum a proprio centro exsurgere necesse est; quapropter diversos habent orbes motusque dissimiles, quoniam interiores absidas constat breviores esse. Igitur a terrae centro absides altissimae sunt saturno in scorpione, iovi in virgine, marti in leone, soli in geminis, veneri in sagittario, mercurio in capricorno, mediis eorundem signorum partibus et e contrario, id est in signis contrariis, ad terrae centrum humillimae atque proximae. Sic fit ut tardius moveri et minores videantur cum altissimo ambitu feruntur, cum vero terrae adpropinquaverint maiores esse et celerius ferri, non quia adcelerent tardentve naturales motus qui certi ac singuli sunt illis, sed quia deductas a summa abside lineas coartari ad centrum necesse est, sicut in rotis radios ut subiecta figura demonstrat.[5]

The three planets which we said are above the Sun, are hidden while traveling with it, then have morning risings never more than 11° away from the Sun; subsequently, directed by its rays they make morning stations at trine, or 120°, called first [stations], and next in opposition at 180° they make their evening risings. And again at 120° approaching on the other side they make evening, or second, stations. Then the Sun overtakes and obscures them at an interval of 12°, known as their evening settings.

The planet Mars, being nearer [the Sun than the others], senses the rays at 90° after each rising and remains stationary in the zodiac for six months, otherwise for two months, while the other two [superior planets] do not remain at station even four months. The two planets below the Sun are similarly obscured at evening conjunction, and they make their morning risings at the same number of degrees from the Sun, at which from the greatest limits of their distance they follow the Sun. Overtaking the Sun, at morning setting they are obscured and are not seen. Once again in the evening they rise at the same interval as far as the limits we have stated, from which they retrogress toward the Sun and disappear in their evening setting. The planet Venus makes two stations morning and evening from each rising from the farthest limits of her elongation. Mercury's stations take too brief a time to be seen.

The cause of this must be made known here separately. Struck at that angle we stated and by a triangular solar ray, they are prevented from continuing a direct course and are pushed upward by the fiery force [of the ray]. We cannot see this

[5]Plinius (1888), pp. 37-40.

directly, and so they are perceived to stop, and thus they receive the name of station. The violence of the same ray then moves ahead and compels the affected planets to go backward. This occurs much more at their evening risings, when moving away from the Sun, when they are driven into their fullest apogee and are least visible, for they are farthest away and are producing the least motion. So much the less when this occurs in the most distant signs of the absides. In the Greek language the circles of these [planetary paths] are called absides. These are not the same as those of the sidereal sphere, since the Earth is between two vertices that they call poles and is seen to be at the center of both the sidereal sphere and the zodiac. Thus it is necessary that each one of the absides rise from its own center; wherefore they have different orbits and different motions, since the inner absides are smaller circles. Therefore from the center of the Earth the apogees are Saturn in Scorpio, Jupiter in Virgo, Mars in Leo, Sun in Gemini, Venus in Sagittarius, Mercury in Capricorn, at the midpoints of these signs, and on the contrary in the opposite signs being the lowest and closest to the center of the Earth. Thus it happens that they seem smaller and to be moved slower when they travel in their highest pathway and to be larger and to move faster when they have approached nearer to the Earth. This is not because the natural motions, which are definite and unique to each planet, accelerate and slow down, but because lines drawn from the outer absis (the apogee) toward the center must crowd together, just like the spokes in a wheel, as the figure below (Fig. II.5) shows.[6]

4 LATITUDES DIAGRAM

4.1 DESCRIPTION

Plinian Latitudes—Circular

The latitude of a planet is the inclination of its orbit to the plane of the ecliptic. The circular presentation of planetary latitudes (Fig. II.7) occurs against a framework of thirteen concentric circles spaced at equal radial intervals. Each space between two succeeding circles represents 1° of the zodiacal band of 12° in width. The middle, or seventh, circle represents the plane of the ecliptic. Against this framework the path of every planet but one, the Sun, appears as a circle that intersects one or more of the circles of the zodiac. The Sun's path, because of the text of Pliny, follows a serpentine line that focuses on the middle circle and passes above and below it to touch the next circle on either side of the middle circle.

With the zodiacal circles numbered from 1 to 13, from the center outward, the Moon touches circle 13 on one side of the diagram and circle 1 on the opposite

[6] Our translation.

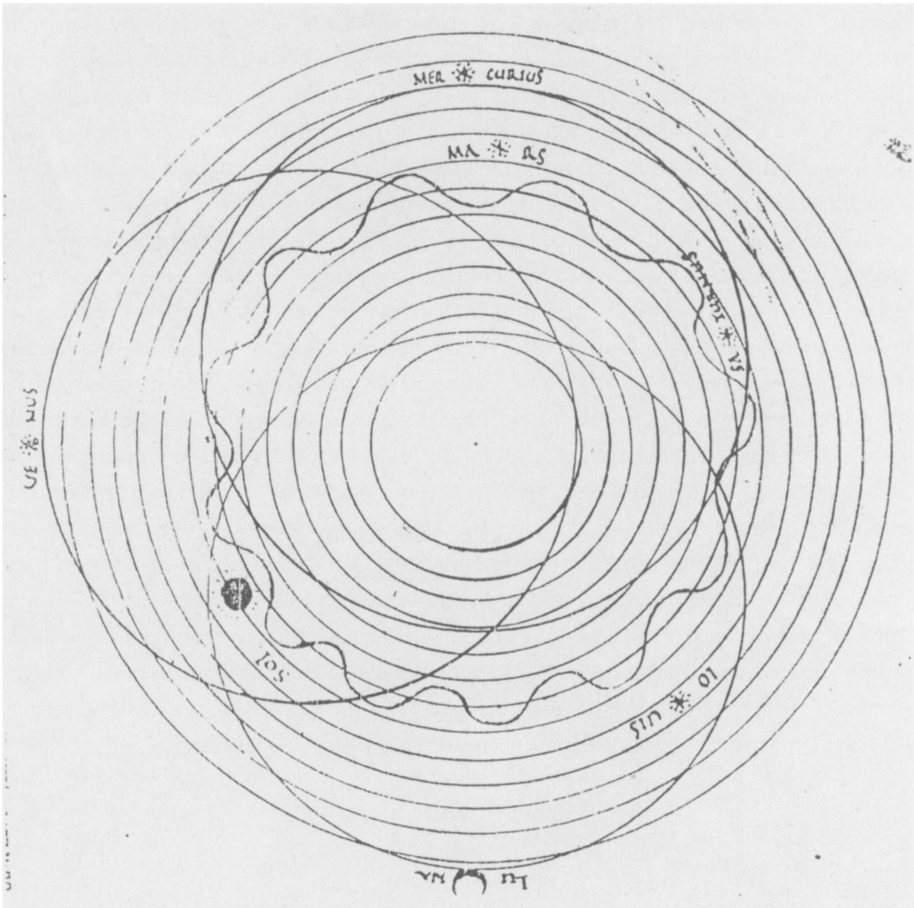

Figure II.7. Latitudes—circular. Burgerbibliothek Bern, Cod. 347, f.25r. Copyright Burgerbibliothek Bern.

side; this represents Pliny's assignment of 12° for the lunar latitude. The diagram shows Venus extending beyond circle 13 and cutting inside circle 1 to represent Pliny's 2° beyond the zodiacal width for this planet's latitude. Mercury has a latitude of eight, from circle 11 to circle 3. Mars has a latitude of four in the middle, from circle 9 to circle 5. Jupiter, with 3° of latitude in Pliny's text, moves from circle 9 to circle 6. Saturn receives 2° of latitude "like the Sun" according to Pliny's text. Nowhere does Pliny specify that Saturn has a serpentine path like that ascribed

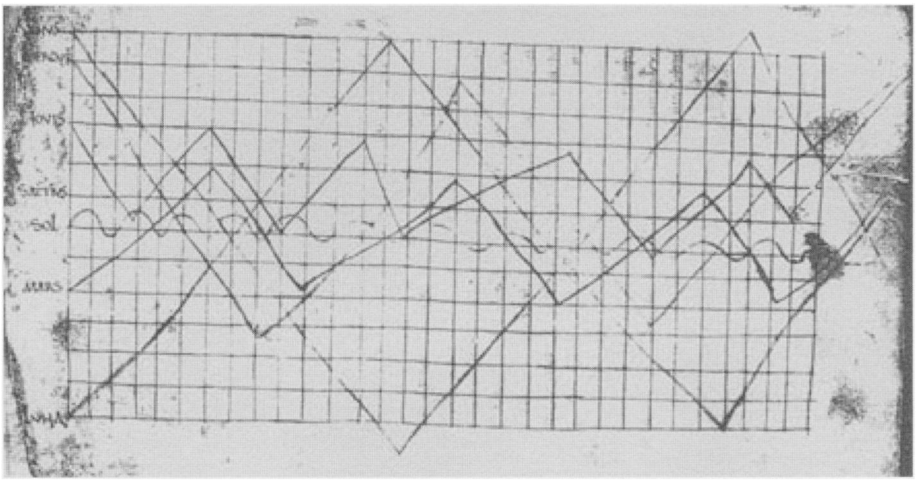

Figure II.8. Latitudes—rectangular. London British Library, ms Roy. 13.A.XI, f.143v. By permission of the British Library.

to the Sun, and his phrase "like the Sun" appears to mean the same 2° as the Sun supposedly crosses in the zodiac; most of the diagrams place Saturn's name outside the solar serpentine path and provide no separate circle for the latitude of Saturn.

Plinian Latitudes—Rectangular

The rectangular presentation of latitudes (Fig. II.8)occurs against a grid created by the intersections of 13 equally spaced horizontal lines with 31 equally spaced vertical lines —a grid of 12 × 30 small squares. While this is the most common framework for the latitudes in this form, the grid may be drawn with different numbers of lines, such as, 12 × 20. The 13 horizontal lines, which provide 12 intervals vertically, are the critical element in the layout. As in the circular diagram each planet oscillates between two extreme limits, but here the limits are upper and lower horizontals rather than the inner and outer circles of the circular form. In the rectangular grid, the path of each planet has a regular wavelike pattern as it oscillates between its latitudinal limits. The names of the seven planets appear vertically on the left side of the grid. In accord with Pliny's text, the Sun follows a serpentine path in the two middle intervals, or degrees. Saturn is rarely given an independent line of travel, and its name appears next to the Sun's name. The Moon passes from the bottom line to the top line, covering the full band of the zodiac. Venus has an interval from a small distance above the grid to a small distance below

the grid, representing Pliny's assignment of an extra 2°, beyond the zodiacal band, to this planet's latitude. Mercury begins its line, according to Pliny's description, five spaces above the central horizontal line and descends to the line that is three spaces below the central horizontal line. Mars begins two spaces below the central and moves as high as the second line above the central horizontal. Jupiter begins three spaces below the central and travels only as high as the central horizontal. The prescribed numbers of degrees of latitude in the Plinian excerpt are often not well represented by the diagrams. While a few diagrams provide a separate line for the latitude of Saturn, the large majority do not. The overall impression of most rectangular latitude diagrams is that of six wavelike lines progressing from left to right across the grid framework.

4.2 Text and Translation

DE CURSU EARUM PER ZODIACUM CIRCULUM. Cur autem magnitudines suas et colores mutent et eaedem ad septentriones accedant abeantque ad austrum, latitudo signiferi et obliquitas facit. Per hunc enim illae feruntur, nec aliud habitatur in terris quam quod illi subiacet; reliqua a polis squalent. Veneris tantum stella excedit eum binis partibus. Luna per totam latitudinem eius vagatur, sed onmino non excedens eum. Ab his mercurii stella laxissime, ut tamen e duodenis partibus, tot enim sunt latitudinis, non amplius octonas pererret, neque has aequaliter sed duas medio eius, et supra quattuor, infra duas. Sol deinde medio fertur inter duas partes flexuoso draconum meatu inaequalis. Martis stella quattuor mediis, iovis media et super eam duabus, saturni duabus ut sol. Tres superiores ab exortu matutino latitudinem signiferi scandere incipiunt, id est ad aquilonem accedere, ab exortu vero vespertino descendere, hoc est ad austrum abire, superveniente ab alio latere solis radio eademque vi rursus ad terras deprimente qua sustulerat in caelum. Tantum interest sueant radii an superveniant. Veneris stella simili modo ab exortu matutino latitudinem scandere, vespertino autem descendere incipit, in occasu vero matutino altitudinem subire et in statione vespertina retro ire simulque altitudine degredi. Mercurius ab exortu matutino utroque modo scandere, id est latitudine et altitudine, ab exortu autem vespertino latitudine degredi, consecutoque sole ad quindecim partium intervallo, consistit quadriduo prope immobilis. Mox ab altitudine descendit retroque graditur ab occasu vespertino usque ad exortum matutinum. Tantumque haec una totidem diebus quot subierat descendit. Veneris quindecies pluribus subit quam descenderat, saturni et iovis duplicato degrediuntur quam ascenderant, martis etiam quadruplicato descendit; tanta est naturae varietas. Martis sidus numquam stationem facit, iovis sidere in triangulo sibi posito, raro tamen aliquando LX partibus discreto; exortus vero simul tantum in duobus signis cancro et leone faciunt. Mercurii vero sidus exortus vespertinos

in piscibus raros facit, creberrimos in virgine, matutinos item in aquario, rarissimos in leone, retrogradum in tauro et geminis non fieri, in cancro vero non citra vicesimam quintam partem. Lunam bis coitum cum sole in nullo alio signo facere quam geminis, non coire aliquando in sagittario tantum, novissimam vero primamque eadem die vel nocte nullo alio in signo quam ariete conspici. Sentit quidem et ipsa ingruentium solis radiorum differentiam. In quadrato a sole dimidia nitet, in triangulo tertia tantum portione ambit, obscura in adverso impletur, rursusque minuens easdem figuras paribus edit intervallis, simili ratione qua supra solem tria sidera. Non conparere in caelo saturni sidus et martis cum plurimum diebus CLXX, iovis XXXVI aut cum minimum denis detractis diebus, veneris LXXVIIII (ed. King: LXVIIII), aut cum minimum LII, mercurii XII, aut cum plurimum XVII. Cur autem non videantur, coitus solis et commissurae absidum et extremae circulorum orbitae in causa esse noscuntur, quoniam his tantum in locis obscurantur, sed tum maxime pluribus diebus non cerni sidera cum in absidum commissuris atque extremitatibus cirulorum stationaria esse contigerit. Nituntur etiam in vaporem solis et quamquam aegre, descendunt tamen. Sed inter omnia haec sidera martis maxime inobservabilis est cursus.[7]

Why do they [planets] change their sizes and colors and approach to the north and depart to the south? The latitude and obliquity of the zodiac are responsible. Because of this those things happen, nor is any place on earth inhabited unless it lies beneath it [the limits of the zodiacal band]; all else is desiccated by [closeness to] the poles. The planet Venus surpasses it [the limit] by 2°; the Moon travels across the whole width [of the zodiacal band] but does not exceed it at all. Mercury is quite different from these, not traversing more than 8° of the 12° of zodiacal latitude, nor are these equally divided but with two in the middle, four above, and two below. The Sun moves unevenly in the middle, in a serpentine path between 2°. Mars travels 4° in the middle, Jupiter the middle degree and two above it, and Saturn two like the Sun.

The three upper planets from morning rising begin to ascend the band of the zodiac, that is, to approach northward, and from evening rising to descend, that is, to depart southward. A solar ray coming on the other side from above presses down towards the Earth with the same force with which it pushes up towards the heavens, so much does it depend on whether the rays come from below or from above. Venus likewise increases in latitude from morning rising and begins to descend at evening, in morning setting to decrease its altitude, and at evening station to go backward and at the same time to decrease in altitude. From

[7] Plinius (1888), pp. 40-3.

morning rising Mercury ascends in both ways, that is, in latitude and in altitude; from evening rising it decreases in latitude and follows the Sun at an interval of 15°, remaining almost motionless for four days. Next it descends from its altitude and goes back from its evening setting to its morning rising. And just this one [planet] sets in as many days as it rises. Venus rises in fifteen times as many days as its setting. On the other hand Saturn and Jupiter take twice as long to set as to rise, and Mars sets in four times as long. Such is the variety of nature. The planet Mars never makes a station when Jupiter is located 120° from it and only rarely when Jupiter is at 60° but the two planets rise together when they are in the signs of Cancer and Leo. Mercury makes infrequent evening risings in Pisces and most often in Virgo, morning risings in Aquarius but hardly ever in Leo. Its retrograde does not occur in Taurus and Gemini and not within the first 25° of Cancer.

In no other sign than Gemini does the Moon make conjunction twice with the Sun; in Sagittarius they have no conjunction at all. The very last visibility and the first new moon are observed on the same day or night only under the sign of Aries. It [the Moon] is sensitive to change in the angle of impact of solar rays. At quadrature from the Sun half of the Moon is shining; at trine one-third part travels hidden, at opposition it is full. And again in waning it shows the same shapes at the same intervals, moving according to the same reasoning [,unlimited in elongation from the Sun,] as the three suprasolar planets.

The planets Saturn and Mars are not invisible for more than 170 days, Jupiter no more than 36 days, with the minimum for each of these being 10 days less. For Venus [the maximum is] 69 days or a minimum of 52, for Mercury 12 or a maximum of 17. Why are they not seen? Conjunction with the Sun, [occultation at the] crossings of the apsides, and the extreme distances of orbits are known causes, since they are obscured at these points. Then maximally, for many days the planets are not seen when stationary at the crossing of apsides and at the farthest distances of their orbits. And so they make their way in the press of the Sun, and although weakly they nevertheless descend [toward us]. And among all the planets the path of Mars is the most unobservable.[8]

[8] Our translation.

5 CATALOGUE OF MANUSCRIPTS

No.	Library Reference	Century
Plin1	Avranches BM, 226, f.88r	XII-XIII
Plin2	Berlin SB, Phillipps 1833, f.38r	X(ex)
Plin3	Bern BB, 265, f.58v	XI
Plin4	Bern BB, 265, f.59r	XI
Plin5	Bern BB, 347, f.22v	IX(2/2)
Plin6	Bern BB, 347, f.23r	IX(2/2)
Plin7	Bern BB, 347, f.24r	IX(2/2)
Plin8	Bern BB, 347, f.24v	IX(2/2)
Plin9	Bern BB, 347, f.25r	IX(2/2)
Plin10	Cambridge St. John's CL, lat. I.15, p.287	XII
Plin11	Cambridge St. John's CL, lat. I.15, p.353	XII
Plin12	Cambridge Trinity CL, R.15.32, f.3v	XI(in)
Plin13	Durham CathLibr., Hunter 100, f.66r	XII(1/3)
Plin14	Erfurt StB, Ampl. 4°.8, f.1r	XII(m)
Plin15	Erfurt StB, Ampl. 4°.351, f.1v	XII
Plin16	Firenze BML, Plut. 51.14, f.73r	XI(in)
Plin17	Genève FB, 111, f.38r	X(2/2)
Plin18	Genève FB, 111, f.38v	X(2/2)
Plin19	Genève FB, 111, f.39v	X(2/2)
Plin20	Genève FB, 111, f.41r	X(2/2)
Plin21	Glasgow UL, T.4.2, f.117r	XII(2/4)
Plin22	Leiden UB, BPL 168, f.56r	XII(2/2)
Plin23	London BL, Add. 11943, f.49r	XI
Plin24	London BL, Add. 11943, f.49v	XI
Plin25	London BL, Arundel 339, f.153r	XIII
Plin26	London BL, Cott. Tib. C.I, f.40v	XII(in)
Plin27	London BL, Cott. Tib. E.IV, f.141r	XI-XII
Plin28	London BL, Cott. Vit. A.XII, f.9r	XI
Plin29	London BL, Egerton 3088, f.83v	XIII(m)
Plin30	London BL, Harl. 2506, f.53r	X(ex)
Plin31	London BL, Harl. 647, f. 19r	IX(2/4)
Plin32	London BL, Roy. 13.A.XI, f.143v	XI-XII(1/2)
Plin33	London BL, Roy. 15.A.XI, f.240r	X
Plin34	Madrid BN, 3307, f.63v	IX(820-828)
Plin35	Madrid BN, 3307, f.64r	IX(820-828)
Plin36	Madrid BN, 3307, f.65v	IX(820-828)

No.	Library Reference	Century
Plin37	Madrid BN, 3307, f.66r	IX(820-828)
Plin38	Milano BN, E.5 sup., f.1r	XII(2/2)
Plin39	Milano BN, E.5 sup., f.53r	XII(2/2)
Plin40	Monza Bcap, F.9.176, f.70v	IX(3/4)
Plin41	Monza Bcap, F.9.176, f.71r	IX(3/4)
Plin42	Monza Bcap, F.9.176, f.72v	IX(3/4)
Plin43	Monza Bcap, F.9.176, f.73r	IX(3/4)
Plin44	München SB, clm 14436, f.59r	X
Plin45	München SB, clm 14436, f.60v	X
Plin46	München SB, clm 14836, f.120r	XII(in)
Plin47	München SB, clm 14836, f.121v	XII(in)
Plin48	München SB, clm 14836, f.124r	XII(in)
Plin49	München SB, clm 210, f.123r	IX(818)
Plin50	München SB, clm 6362, f.74v	XI
Plin51	München SB, clm 6362, f.75r	XI
Plin52	München SB, clm 6364, f.23v	X(2/2)
Plin53	München SB, clm 6364, f.24r	X(2/2)
Plin54	München SB, clm 6364, f.24v	X(2/2)
Plin55	Oxford BoL, Canon. Class. lat. 279, 32v	IX(ca. 900)
Plin56	Oxford BoL, Canon. Class. lat. 279, f.33r	IX(ca. 900)
Plin57	Oxford BoL, Canon. Class. lat. 279, f.34r	IX(ca. 900)
Plin58	Oxford BoL, Canon. Class. lat. 279, f.33v	IX(ca. 900)
Plin59	Oxford BoL, Lyell 154, f.26v	XI/XII
Plin60	Oxford St. John's CL, lat. 17, f.38r	XII(1/4)
Plin61	Paris BNF, lat. 10195, f.150v	XI
Plin62	Paris BNF, lat. 11130, f.72v	XII
Plin63	Paris BNF, lat. 11130, f.74r	XII
Plin64	Paris BNF, lat. 11130, f.74v	XII
Plin65	Paris BNF, lat. 16680, f.77v	XII(2/2)
Plin66	Paris BNF, lat. 17868, f.2v	X(ex)
Plin67	Paris BNF, lat. 2389, f.50v	XII
Plin68	Paris BNF, lat. 5239, f.125v	X(m)
Plin69	Paris BNF, lat. 5239, f.38r	X(m)
Plin70	Paris BNF, lat. 5239, f.38v	X(m)
Plin71	Paris BNF, lat. 5239, f.39r	X(m)
Plin72	Paris BNF, lat. 6367, f.1v	XIV
Plin73	Paris BNF, lat. 7299A, f.25r	XII
Plin74	Paris BNF, lat. 8663, f.24r	X(ex)-XI(in)

No.	Library Reference	Century
Plin75	Paris BNF, nal 1615, f.161r	IX(820)
Plin76	Paris BNF, nal 1615, f.159v	IX(820)
Plin77	Paris BNF, nal 1615, f.160v	IX(820)
Plin78	Paris BNF, nal 1615, f.181r	IX(820)
Plin79	St. Gallen StiB, 250, p.2	IX(889)
Plin80	St. Gallen StiB, 250, p.23	IX(889)
Plin81	Strasbourg BU, 326, f.122r	X
Plin82	Strasbourg BU, 326, f.122v	X
Plin83	Strasbourg BU, 326, f.123r	X
Plin84	Strasbourg BU, 326, f.124r	X
Plin85	Torino BN, D.V.38, f.50v	XII(2/2)
Plin86	Vaticano BAV, Palat. lat. 1577, f.80r	XI(in)
Plin87	Vaticano BAV, Palat. lat. 1577, f.80v	XI(in)
Plin88	Vaticano BAV, Palat. lat. 1577, f.81v	XI(in)
Plin89	Vaticano BAV, Palat. lat. 1577, f.82v	XI(in)
Plin90	Vaticano BAV, Palat. lat. 1577, f.83r	XI(in)
Plin91	Vaticano BAV, Palat. lat. 834, f.45v	IX(ca. 836)
Plin92	Vaticano BAV, Regin. lat. 123, f.169r	XI(1056)
Plin93	Vaticano BAV, Regin. lat. 123, f.169v	XI(1056)
Plin94	Vaticano BAV, Regin. lat. 1573, f.53r	XI
Plin95	Vaticano BAV, Ross. 247, f.199r	IX
Plin96	Vaticano BAV, Ross. 247, f.200r	IX
Plin97	Vaticano BAV, Ross. 247, f.200v	IX
Plin98	Vaticano BAV, Ross. 247, f.209v	IX
Plin99	Vaticano BAV, Vat. lat. 645, f.66v	IX
Plin100	Vaticano BAV, Vat. lat. 645, f.67v	IX
Plin101	Wien NB, cod. 12600, f.27r	XII(ex)
Plin102	Wien NB, cod. 12600, f.27v	XII(ex)
Plin103	Wien NB, cod. 387, f.123r	IX(810)
Plin104	Wien NB, cod. 443, f.171v	XI(1/2)
Plin105	Wroclaw UB, IV.O.11, f.59r	XII
Plin106	Zürich ZB, Car.C.122, f.39v	X(2/2)-XI(1/2)
Plin107	Zürich ZB, Car.C.122, f.41v	X(2/2)-XI(1/2)
Plin108	Zürich ZB, Car.C.122, f.42r	X(2/2)-XI(1/2)

6 CATALOGUE OF DIAGRAMS

No.	Diagram Type	Manuscript Context
Plin7	Plinian apsides—natural	astronomical excerpts
Plin14	Plinian apsides—natural	Macrobius *Commentary*
Plin24	Plinian apsides—natural	Capella astron., Macrobius *Commentary*, astronomy
Plin25	Plinian apsides—natural	astronomy, Macrobius *Commentary*, math
Plin23	Plinian apsides—natural	Macrobius *Commentary*
Plin33	Plinian apsides—natural	Remigius comm. on Capella
Plin36	Plinian apsides—natural	astronomy-computus
Plin40	Plinian apsides—natural	astronomy-computus
Plin47	Plinian apsides—natural	astrolabe, mathematics, measurement
Plin58	Plinian apsides—natural	letters, grammar, Pliny excerpts
Plin61	Plinian apsides—natural	Macrobius, Sallust, Plato, Calcidius
Plin63	Plinian apsides—natural	Pliny, Isidore, Bede, and others
Plin66	Plinian apsides—natural	astronomy-astrology
Plin68	Plinian apsides—natural	computus-astronomy
Plin77	Plinian apsides—natural	astronomy-computus
Plin84	Plinian apsides—natural	computus-astronomy
Plin85	Plinian apsides—natural	Macrobius *Commentary*
Plin92	Plinian apsides—natural	astronomy-computus
Plin96	Plinian apsides—natural	astronomy-computus
Plin3	Plinian apsides—reordered	Macrobius astron. excerpts, Pliny astron. excerpts
Plin19	Plinian apsides—reordered	Macrobius *Commentary*, Pliny excerpts, Boethius *Music*
Plin45	Plinian apsides—reordered	Macrobius *Commentary*, Pliny excerpts
Plin50	Plinian apsides—reordered	Macrobius *Commentary*, Pliny excerpts
Plin53	Plinian apsides—reordered	Macrobius *Commentary*, Pliny excerpts
Plin80	Plinian apsides—reordered	astronomy-computus
Plin88	Plinian apsides—reordered	Capella, Macrobius, Pliny
Plin107	Plinian apsides—reordered	Macrobius, Pliny excerpts

No.	Diagram Type	Manuscript Context
Plin26	Plinian intervals of planets—concentric	computus-astronomy
Plin31	Plinian intervals of planets—concentric	Pliny, Isidore, Bede, and others
Plin35	Plinian intervals of planets—concentric	astronomy-computus
Plin41	Plinian intervals of planets—concentric	computus-astronomy-astrology
Plin49	Plinian intervals of planets—concentric	computus-astronomy
Plin62	Plinian intervals of planets—concentric	astronomy-computus
Plin67	Plinian intervals of planets—concentric	astronomy-computus
Plin73	Plinian intervals of planets—concentric	astronomy-computus
Plin76	Plinian intervals of planets—concentric	*Timaeus*, computus, cosmology
Plin82	Plinian intervals of planets—concentric	computus-astronomy
Plin91	Plinian intervals of planets—concentric	astronomy, Pliny excerpts
Plin95	Plinian intervals of planets—concentric	computus-astronomy
Plin99	Plinian intervals of planets—concentric	computus-astronomy
Plin102	Plinian intervals of planets—concentric	computus-astronomy
Plin103	Plinian intervals of planets—concentric	astronomy-computus
Plin6	Plinian intervals of planets—listed	astronomical excerpts
Plin18	Plinian intervals of planets—listed	astrolabe, mathematics, measurement
Plin28	Plinian intervals of planets—listed	Macrobius *Commentary*, Pliny excerpts
Plin44	Plinian intervals of planets—listed	Macrobius *Commentary*, Pliny excerpts, Boethius *Music*

No.	Diagram Type	Manuscript Context
Plin46	Plinian intervals of planets—listed	computus-astronomy
Plin51	Plinian intervals of planets—listed	Letters, grammar, Pliny excerpts
Plin52	Plinian intervals of planets—listed	Macrobius *Commentary*, Pliny excerpts
Plin55	Plinian intervals of planets—listed	Letters, grammar, Pliny excerpts
Plin56	Plinian intervals of planets—listed	computus-astronomy
Plin70	Plinian intervals of planets—listed	Macrobius, Pliny excerpts
Plin81	Plinian intervals of planets—listed	computus-astronomy
Plin87	Plinian intervals of planets—listed	computus-astronomy
Plin10	Plinian latitudes—circular	astronomy-computus
Plin12	Plinian latitudes—circular	Macrobius astron. excerpts, Pliny astron. excerpts
Plin9	Plinian latitudes—circular	astronomical excerpts
Plin37	Plinian latitudes—circular	astronomy-computus
Plin43	Plinian latitudes—circular	astronomy-computus
Plin48	Plinian latitudes—circular	astrolabe, mathematics, measurement
Plin64	Plinian latitudes—circular	Pliny, Isidore, Bede, and others
Plin75	Plinian latitudes—circular	astronomy-computus
Plin90	Plinian latitudes—circular	Capella, Macrobius, Pliny
Plin93	Plinian latitudes—circular	cosmology-astronomy
Plin97	Plinian latitudes—circular	astronomy-computus
Plin104	Plinian latitudes—circular	
Plin1	Plinian latitudes—rectangular	cosmology-astronomy, Capella
Plin8	Plinian latitudes—rectangular	astronomical excerpts
Plin10	Plinian latitudes—rectangular	computus-astronomy
Plin11	Plinian latitudes—rectangular	computus-astronomy
Plin12	Plinian latitudes—rectangular	astronomy-computus
Plin13	Plinian latitudes—rectangular	astronomy-computus
Plin15	Plinian latitudes—rectangular	Capella astronomy

No.	Diagram Type	Manuscript Context
Plin20	Plinian latitudes—rectangular	Macrobius *Commentary*, Pliny excerpts, Boethius *Music*
Plin21	Plinian latitudes—rectangular	computus-astronomy
Plin22	Plinian latitudes—rectangular	Macrobius *Commentary*
Plin24	Plinian latitudes—rectangular	Macrobius *Commentary*
Plin27	Plinian latitudes—rectangular	annals, astronomy-computus
Plin29	Plinian latitudes—rectangular	computus-astronomy
Plin32	Plinian latitudes—rectangular	computus-astronomy
Plin38	Plinian latitudes—rectangular	*Timaeus* with comm.
Plin39	Plinian latitudes—rectangular	*Timaeus* with comm.
Plin54	Plinian latitudes—rectangular	Macrobius, Pliny excerpts
Plin57	Plinian latitudes—rectangular	computus-astronomy
Plin59	Plinian latitudes—rectangular	computus-astronomy
Plin70	Plinian latitudes—rectangular	astronomy-computus-cosmology
Plin71	Plinian latitudes—rectangular	computus-astronomy
Plin72	Plinian latitudes—rectangular	Macrobius *Commentary* and *Saturnalia*
Plin79	Plinian latitudes—rectangular	astronomy-computus
Plin81	Plinian latitudes—rectangular	computus-astronomy
Plin89	Plinian latitudes—rectangular	Capella, Macrobius, Pliny
Plin94	Plinian latitudes—rectangular	computus-astronomy
Plin105	Plinian latitudes—rectangular	astronomy-computus-geography-math
Plin108	Plinian latitudes—rectangular	Macrobius, Pliny excerpts
Plin34	Plinian order of planets—concentric	astronomy-computus
Plin42	Plinian order of planets—concentric	astronomy-computus
Plin78	Plinian order of planets—concentric	astronomical excerpts
Plin98	Plinian order of planets—concentric	astronomy-computus
Plin100	Plinian order of planets—concentric	astronomy-computus
Plin101	Plinian order of planets—concentric	astronomy-computus
Plin13	Plinian order of planets—listed	astronomical excerpts

No.	Diagram Type	Manuscript Context
Plin25	Plinian order of planets—listed	astronomy-computus
Plin65	Plinian order of planets—listed	Macrobius *Commentary*, Pliny excerpts
Plin69	Plinian order of planets—listed	Macrobius, Pliny excerpts
Plin74	Plinian order of planets—listed	Macrobius *Commentary*, Pliny excerpts
Plin86	Plinian order of planets—listed	computus-astronomy
Plin106	Plinian order of planets—listed	Macrobius *Commentary*, astronomy

Chapter III

MACROBIAN DIAGRAMS

1 Zodiacal Configuration Diagram

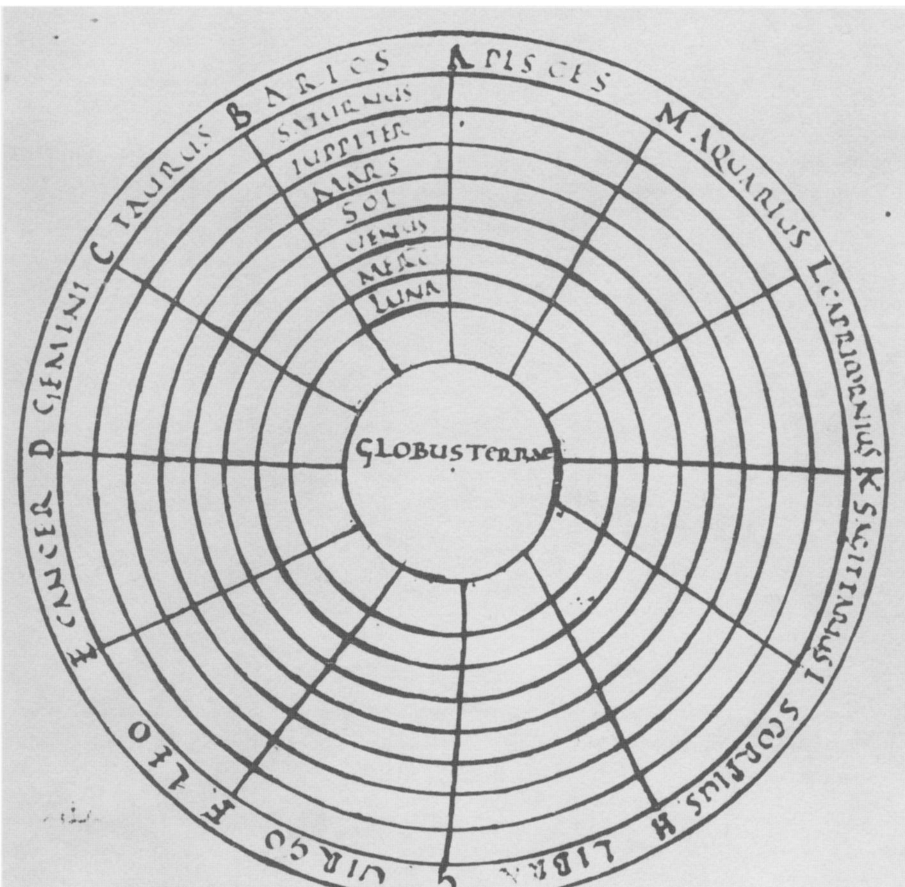

Figure III.1. Zodiacal configuration: Plinian order under one sign. Burgerbibliothek Bern, Cod. 347, f. 9r. Copyright Burgerbibliothek Bern.

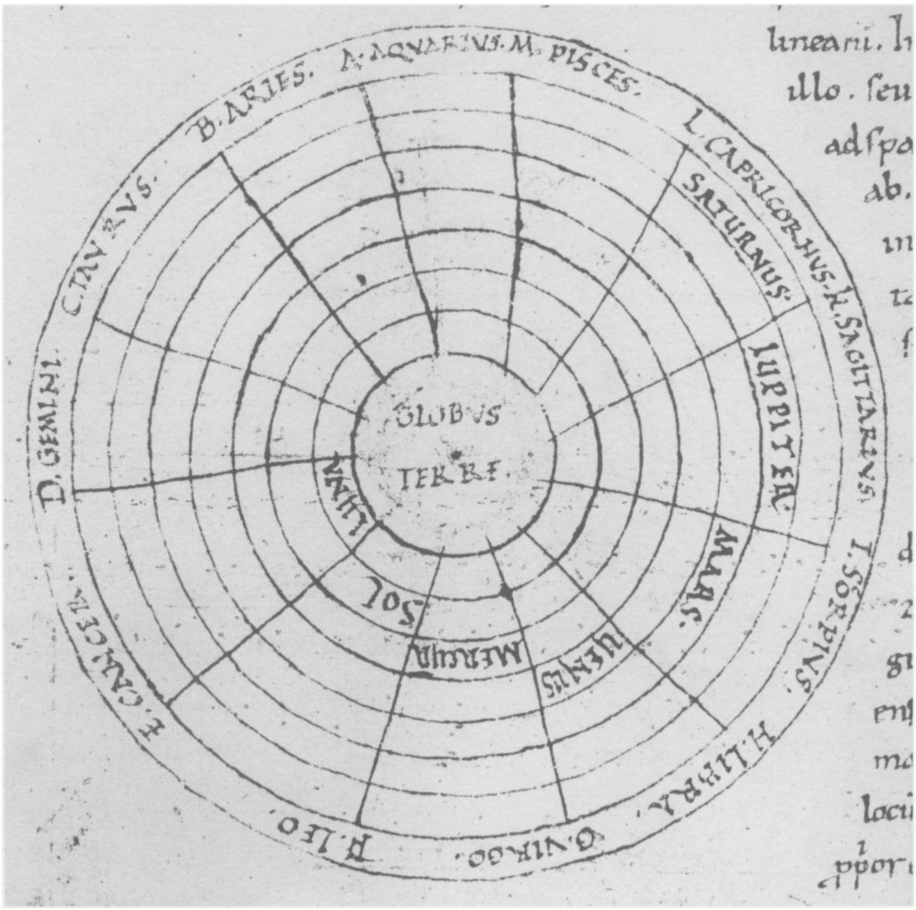

Figure III.2. Zodiacal configuration: Platonic order under successive signs. London British Library, Ms. Harl. 2772, f.61v. By permission of the British Library.

1.1 DESCRIPTION

This is the only planetary diagram prescribed by the text of Macrobius. While the framework remains constant in virtually all examples cited from the manuscripts, the details of the planetary order or orders within the framework show much variation. These variations in planetary order take two main forms, and each of these forms has two main variants. There exist two further major variations in a very small number of manuscripts.

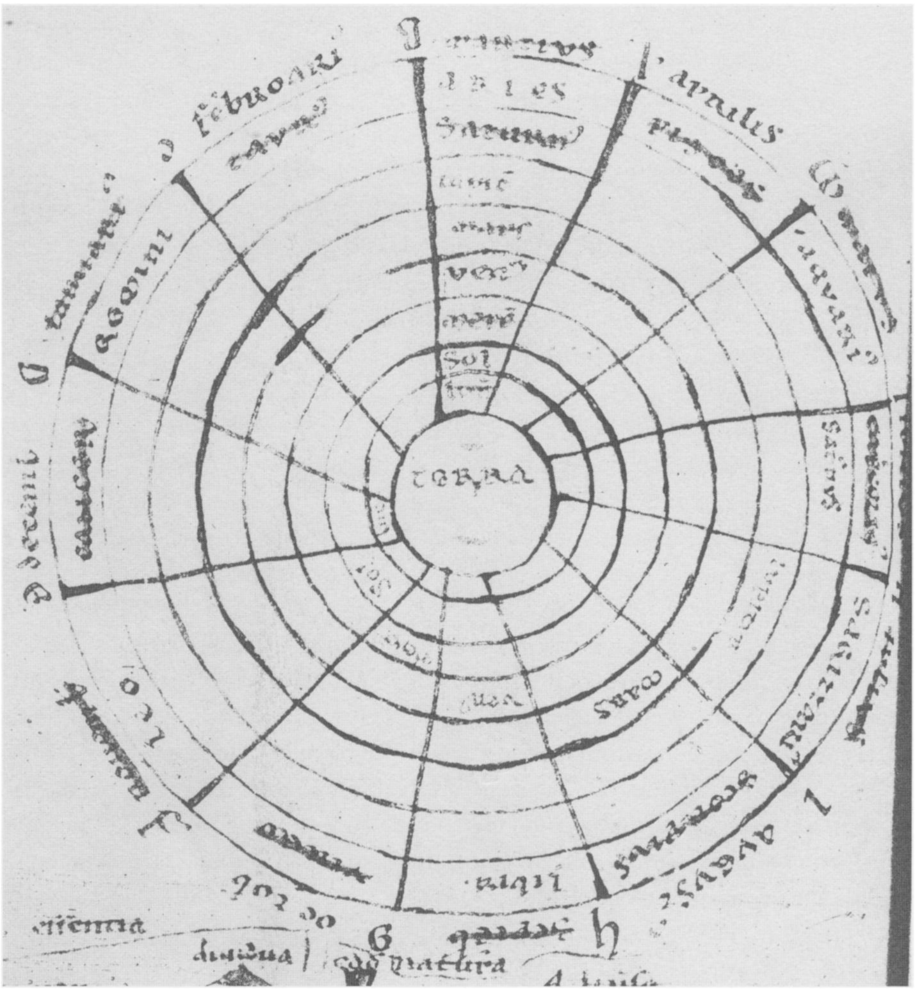

Figure III.3. Zodiacal configuration: Platonic order under one sign and under successive signs. London British Library, Ms. Egerton 2976, f.37bis. By permission of the British Library.

The framework follows Macrobius's description (I.xxi.3-7, 24-27) and appears as follows. A circular band is divided into twelve equal parts, with the twelve radii extending almost to the center and ending at the periphery of a small central circle. Beginning at 12 o'clock and proceeding counterclockwise, each sign of the zodiac is named in each successive section of the band, with Aries 0° at 12

o'clock (or, often at 1 o'clock). Outside the zodiacal band are the letters A - M, in counterclockwise succession beginning at Aries 0°, at the ends of the radial lines. The small central circle is labeled for Earth. Between this central circle and the zodiacal band are six concentric circles, dividing the radial lines into seven equal segments between the terrestrial circle and the zodiacal band. The planets are placed in the resulting seven circular bands between the Earth and the zodiac.

Macrobius prescribes the order of the planets at three different places in his commentary; only two of these passages seem to influence the Macrobian diagrams. One order appears in the text's description of the planetary configuration, following what Macrobius calls the Platonic order (I.xxi. 24). This order, or sequence, ascends from Earth as follows: Moon, Sun, Mercury, Venus, Mars, Jupiter, Saturn. In addition, the Macrobian description places each planet under a different zodiacal sign, so that we see not only an ascending sequence but also the distribution of this sequence in a revolving pattern. The text places Saturn under Capricorn, Jupiter under Sagittarius, Mars under Scorpius, Venus under Libra, Mercury under Virgo, Sun under Leo, and Moon under Cancer. The text goes on to describe a further distribution of five planets to fill the remaining five zodiacal signs, always preserving the planetary order that Macrobius calls Platonic (above). The text gives a second sign to each planet except Sun and Moon. Saturn receives its second placement under Aquarius, Jupiter under Pisces, Mars under Aries, Venus under Taurus, and Mercury under Gemini. The complete arrangement prescribed by Macrobius here sets out the Platonic order twice, each time distributed over suceeding signs of the zodiac. We describe a manuscript diagram conforming to this pattern with the attributes "2b + 2b" (order 2, arrangement b, appearance twice in the diagram).

The same zodiacal framework can and does contain other planetary orders than the above. In an earlier passage of the text (I.xix.1-9), Macrobius described both a Caldean order (the same as Pliny and Ptolemy) and an Egyptian order (the Macrobian version of Plato), but he did not prescribe a diagram at this point. The Caldean/Plinian order most often appears in the seven band-segments under a single sign, usually Aries. This pattern is classified as 1a (order 1, arrangement a, appearance once in the diagram).

The two typical orders are Caldean/Plinian (order 1) and Egyptian/Platonic (order 2). Either of these may appear listed under a single sign (arrangement a) or distributed in a revolving pattern over seven signs (arrangement b). Each planetary order is always given the letter corresponding to its arrangement in the zodiacal framework (a or b). If more than one order appears, each is listed in additive sequence (e.g., 1a + 2b). If the same order appears twice, it is listed twice in additive sequence (e.g., 1a + 1b). The diagrams of the Macrobian planetary configuration

always appear in the page space provided for text, unless otherwise indicated by our description of attributes.

1.2 TEXT AND TRANSLATION

Et quia facilior ad intellectum per oculos via est, id quod sermo descripsit visus adsignet. esto enim zodiacus circulus, cui adscriptum est A; intra hunc septem alii orbes locentur, et zodiacus ab A per ordinem adfixis notis, quibus adscribentur litterae sequentes, in partes duodecim dividatur: sitque spatium quod inter A et B clauditur Arieti deputatum, quod inter B et C Tauro, quod inter C et D Geminis, Cancro quod sequitur, et reliquis per ordinem cetera. [4] his constitutis iam de singulis zodiaci notis et litteris singulae deorsum lineae per omnes circulos ad ultimum usque ducantur: procul dubio per omnes singulos duodenas partes dividet transitus linearum. in quocumque igitur circulo seu sol in illo seu luna vel de vagis quaecumque discurrat, cum ad spatium venerit, quod inter lineas clauditur ab A et B notis et litteris defluentes, in Ariete esse dicetur quia illic constituta spatium Arietis in zodiaco designatum super verticem sicut descripsimus habebit. similiter in quamcumque migraverit partem, in signo sub quo fuerit esse dicetur.

[5] Atque haec ipsa descriptio eodem compendio nos docebit cur eundem zodiacum eademqu signa aliae tempore longiore, aliae breviore percurrant. quotiens enim plures orbes intra se locantur, sicut maximus est ille qui primus est et minimus qui locum ultimum tenet, ita de mediis qui summo propior est inferioribus maior, qui vicinior est ultimo brevior superioribus habetur. [6] et inter has igitur septem sphaeras gradum celeritatis suae singulis ordo positionis adscripsit. ideo stellae quae per spatia grandiora discurrunt, ambitum suum tempore prolixiore conficiunt; quae per angusta, breviore. constat enim nullam inter eas celerius ceteris tardiusve procedere: sed cum sit omnibus idem modus meandi, tantam eis diversitatem temporis sola spatiorum diversitas facit. [7] nam ut de mediis nunc praetermittamus, ne eadem saepe repetantur, quod eadem signa Saturnus annis triginta, luna diebus viginti octo ambit et permeat, sola causa in quantitate est circulorum, quorum alter est maximus, alter est minimus: ergo et ceterarum singulae pro spatii sui modo tempus meandi aut extendunt aut contrahunt.

[...] [24] [...] Aiunt enim in hac ipsa genitura mundi, Ariete ut diximus medium caeli tenente, horam fuisse mundi nascentis, Cancro gestante tunc lunam. post hunc sol cum Leone oriebatur, cum Mercurio Virgo, Libra cum Venere, Mars erat in Scorpio, Sagittarium Iuppiter obtinebat, in Capricorno Saturnus meabat. [25] sic factum est ut singuli eorum signorum domini esse dicantur, in quibus, cum mundus nasceretur, fuisse creduntur sed duobus quidem luminibus singula tantum signa, in quibus tunc fuerant, adsignavit antiquitas, Cancrum lunae, soli Leonem; quinque vero stellis praeter illa signa, quibus tunc inhaerebant, quinque reliqua sic

adiecit vetustas ut in adsignandis a fine prioris ordinis ordo secundus inciperet. [26] superius enim diximus in Capricorno Saturnum post omnes fuisse. ergo secunda adiectio eum primum fecit qui ultimus fuerat, ideo Aquarius qui Capricornum sequitur, Saturno datur; Iovi qui ante Saturnum erat Pisces dicantur; Aries Marti qui praecesserat Iovem Taurus Veneri quam Mars sequebatur, Gemini Mercurio, post quem Venus fuerat, deputati sunt. [27] notandum hoc loco quod in genitura mundi vel ipsa rerum providentia vel vetustatis ingenium hunc stellis ordinem dedit quem Plato adsignavit sphaeris earum, ut esset luna prima, sol secundus, super hunc Mercurius, Venus quarta, hinc Mars, inde Iuppiter, et Saturnus ultimus. sed sine huius tamen rationis patrocinio abunde Platonicum ordinem prior ratio commendat.[1]

Since our eyes often open the way to the understanding of a problem, it would be well to draw a diagram. Let a circle marked A represent the zodiac; within it draw seven concentric circles. Divide the outer circle into twelve parts, assigning in sequence the letters A to M to the divisions. Allot the space between A and B to Aries, between B and C to Taurus, between C and D to Gemini, the next to Cancer, and so on around the circle. [4] Next, draw lines from each division on the outer circle towards the center, passing through the circles and extending to the innermost one; of course these intersecting lines will divide each circle into twelve parts. When the Sun or Moon or any planet has advanced in its sphere to an area that is bounded by the lines originating in the marks at A and B, it will be said to be „in“ Aries because in that position it will have directly over it the space marked out on the zodiac as belonging to Aries, as we explained above. Likewise, into whatever sector the planet passes it will be said to be in the sign that is above it. [5] In addition, this diagram will show us with equal facility why some planets course through the same zodiac and the same constellations in a longer period of time and others in a shorter period. Whenever many concentric circles are placed one within another, the outermost one is the greatest and the innermost the smallest, and likewise the one nearest the outermost circle is greater than those beneath it, and the one next to the innermost circle is smaller than those above it. [6] The time required for each planet's revolution is determined, therefore, by its position among these seven spheres. The planets that course through the greater spaces complete their circuits in longer periods of time, those in the shorter spaces in less time. It is a fact that no planet moves more swiftly or more slowly than the others; since they all move at the same rate of speed, the difference in the distance traversed is alone responsible for the difference in time consumed. [7]

[1] Macrobius (1970), pp. 85-6, 89-90.

For example, omitting the intermediate planets to avoid repetition, Saturn in thirty years passes through the same signs that the Moon traverses in twenty-eight days. The only explanation for this difference is the difference in distances covered by their spheres, one being the greatest and the other the smallest; thus the time consumed in each planet's revolution is in proportion to the amount of space traversed.

[...]They say that when the world was being born, at the very hour of birth, Aries, as mentioned above, occupied the middle of the sky and the Moon was in Cancer. The Sun then rose in Leo, Mercury in Virgo, Venus in Libra, Mars in Scorpio, Jupiter in Sagittarius, and Saturn in Capricorn. [25] Thus it came about that each of the planets was considered lord of the sign in which it was believed to have been when the world was born. The ancients assigned only one sign to the Sun and one to the Moon, those in which they were at the beginning, Cancer to the Moon and Leo to the Sun; but to the other five planets five more signs were allotted in addition to those in which they were stationed at the beginning, the second apportionment being resumed where the first left off. [26] The last planet mentioned above was Saturn in Capricorn. In the second apportionment the order was reversed and thus Aquarius, following Capricorn, was allotted to Saturn, Pisces to Jupiter, Aries to Mars, Taurus to Venus, and Gemini to Mercury. [27] Attention must here be drawn to the fact that Providence itself or the cleverness of the ancients assigned to the planets the same order at the birth of the world that Plato assigned to their spheres: the Moon first, the Sun second, Mercury next, Venus fourth, then Mars, Jupiter, and Saturn. But the Platonic order was well supported by a reason already stated, without reliance upon this last one.[2]

2 DIAGRAMS FOR TWO ORDERS OF INNER PLANETS

2.1 DESCRIPTION

Intersecting-Circles Diagram

The intersecting-circle diagram (Fig. III.4)is not prescribed by the text of Macrobius. The dual planetary order resulting from the diagram is nowhere in the text of Macrobius. The pattern of intersecting circles is a medieval interpretation of Macrobius's text describing two distinct and separate planetary orders (I.xix.1-9), the Caldean and the Egyptian. Macrobius definitely considers the Egyptian order, which he calls Platonic, correct. He considers the Caldean order, which is also that of Pliny and Ptolemy, to be incorrect. According to Macrobius, only one order (Platonic) should ever appear; in ascending sequence from the Earth it is: Moon,

[2] Macrobius (1952), pp. 175-6, 179-80.

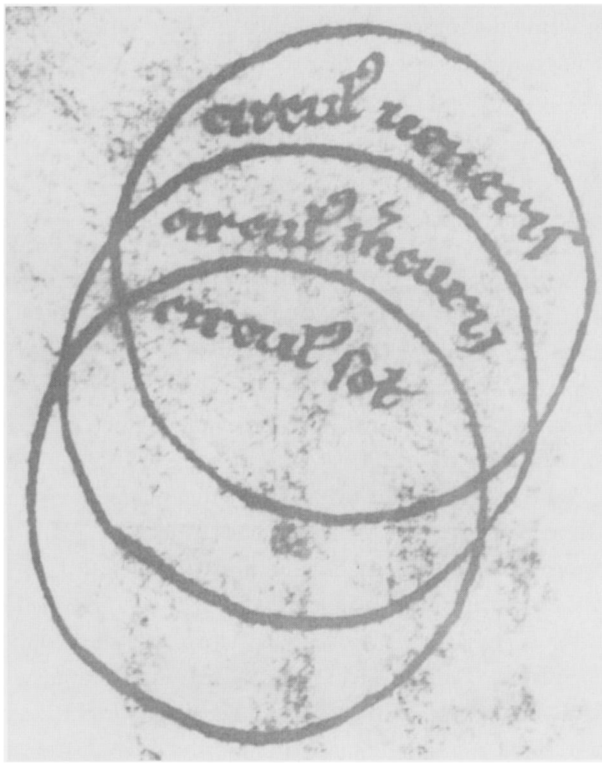

Figure III.4. Inner planets—intersecting circles. Leiden Universiteitsbibliotheek, Ms. BPL 168, f.35v. Reproduced with permission of the Department of Western Manuscripts, University of Leiden.

Sun, Mercury, Venus, Mars, Jupiter, Saturn. Macrobius only describes a pattern of concentric planetary circles.

The pattern of intersecting circles is a medieval invention that allows both the Caldean and the Egyptian orders to exist. The difference between the two appears with the location of the two inner planets, Mercury and Venus. Contrary to the Egyptian order, the Caldean order places these two immediately below the Sun, rather than above it.

The basic type of intersecting-circles diagram puts three planets on three circles, equal in size, each intersecting the other two, with the centers of the three circles on a single straight line and with the two outer center points equidistant

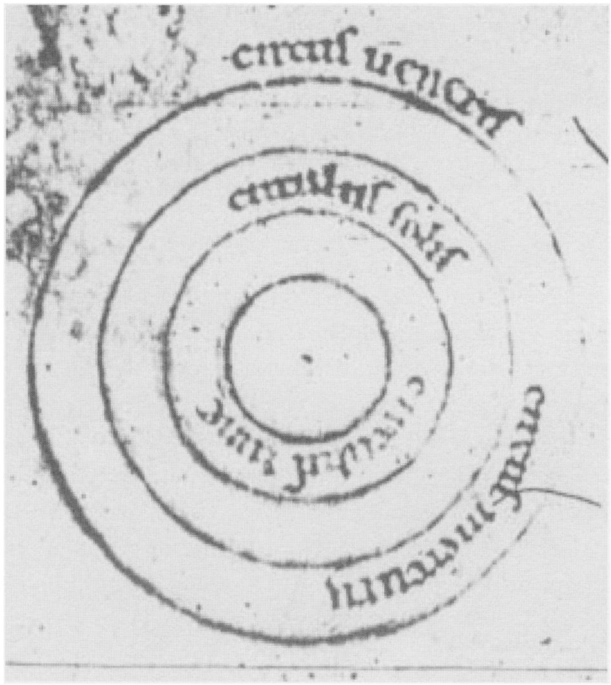

Figure III.5. Inner planets—concentric-circles. Eton Eton College Library, Ms. 90, f.103v. Reproduced by permission of the Provost and Fellows of Eton College.

from the middle center point. The resulting pattern of intersections produces a common middle space that is part of each of the three circles.

This arrangement of intersecting circles explains the changing order of the inner planets. The three planets on these circles are the Sun, Mercury, and Venus. When the centers of the intersecting circles are set on a vertical line, Venus is on the top circle, Mercury is on the middle circle, and the Sun is on the lowest circle. With all planets at their uppermost positions, the order from outermost toward the middle is Venus, Mercury, Sun. At their lowest positions, the order is reversed, with the Sun being from the middle of the diagram and Venus closest to the middle.

The common middle section of the intersecting circles is typically the location of the Moon's circle and the Earth, both of which the three intersecting circles enclose. Either the Moon or the Earth or both or neither may appear in the middle section of the diagram in the manuscripts. The diagrams of intersecting circles normally appear marginally, next to the text. Their most common context

is the text of Macrobius but they often appear with the text of another author (e.g., Capella or Calcidius). They are, of course, a standard part of William of Conches's *Philosophia*, written in the twelfth century; this catalogue does not list diagrams in the manuscripts of the *Philosophia*. Most attributes of these diagrams are described briefly in ordinary language.

Concentric-Circles Diagram

The concentric-circles diagram (Fig. III.5) is not prescribed by the text of Macrobius. It sets the order for the inner planets alone. The diagram requires only three concentric circles, but four concentric circles commonly appear. The concentric circles are separated by equal radial distances. The planetary circles are labeled. From outside inward the first three are Venus, Mercury, Sun; if four circles appear, the innermost is labeled Moon. The diagram appears marginally to the text of Macrobius. It is a medieval reemphasis of the single order of the inner planets supported by Macrobius in his presentation of the Egyptian and Caldean orders of the planets. (See the description for the Macrobian intersecting-circles diagram.)

2.2 TEXT AND TRANSLATION

His adsertis de sphaerarum ordine pauca dicenda sunt, in quo dissentire a Platone Cicero videri potest, cum hic solis sphaeram quartam de septem id est in medio locatam dicat, Plato a luna sursum secundam, hoc est inter septem a summo locum sextum tenere commemoret. [2] Ciceroni Archimedes et Chaldaeorum ratio consentit, Plato Aegyptios omnium philosophiae disciplinarum parentes secutus est, qui ita solem inter lunam et Mercurium locatum volunt, ut rationem tamen et deprehenderint et edixerint, cur a non nullis sol supra Mercurium supraque Venerem esse credatur. nam nec illi qui ita aestimant a specie veri procul aberrant. opinionem vero istius permutationis huius modi ratio persuasit. [3] a Saturni sphaera, quae est prima de septem, usque ad sphaeram Iovis a summo secundam interiecti spatii tanta distantia est, ut zodiaci ambitum superior triginta annis, duodecim vero annis subiecta conficiat; rursus tantum a Iove sphaera Martis recedit, ut eundem cursum biennio peragat. [4] Venus autem tanto est regione Martis inferior, ut ei annus satis sit ad zodiacum peragrandum. iam vero ita Veneri proxima est stella Mercurii et Mercurio sol propinquus, ut hi tres caelum suum pari temporis spatio, id est anno plus minusve, circumeant. ideo et Cicero hos duos cursus comites solis vocavit, quia in spatio pari longe a se numquam recedunt. [5] luna autem tantum ab his deorsum recessit ut, quod illi anno, viginti octo diebus ipsa conficiat. ideo neque de trium superiorum ordine, quem manifeste clareque distinguit immensa distantia, neque de lunae regione, quae ab omnibus multum recessit, inter veteres aliqua fuit dissensio. horum vero trium sibi proximorum, Veneris Mercurii et solis,

ordinem vicinia confudit, sed apud alios; nam Aegyptiorum sollertiam ratio non fugit, quae talis est. [6] circulus per quem sol discurrit a Mercurii circulo ut inferior ambitur, illum quoque superior circulos Veneris includit, atque ita fit ut hae duae stellae cum per superiores circulorum suorum vertices currunt intellegantur supra solem locatae cum vero per inferiora commeant circulorum, sol eis superior aestimetur. [7] illis ergo qui sphaeras earum sub sole dixerunt, hoc visum est ex illo stellarum cursu, qui non numquam ut diximus videtur inferior, qui et vere notabilior est quia tunc liberius apparent. nam cum superiora tenent magis radiis occuluntur, et ideo persuasio ista convaluit, et ab omnibus paene hic ordo in usum receptus est. [8] perspicacior tamen observatio veriorem ordinem deprehendit, quem praeter indaginem visus haec quoque ratio commendat, quod lunam, quae luce propria caret et de sole mutuatur, necesse est fonti luminis sui esse subiectam. [9] haec enim ratio facit lunam non habere lumen proprium, ceteras omnes stellas lucere suo, quod illae supra solem locatae in ipso purissimo aethere sunt, in quo omne quicquid est, lux naturalis et sua est, quae tota cum igne suo ita sphaerae solis incumbit, ut caeli zonae quae procul a sole sunt perpetuo frigore oppressae sint sicut infra ostendetur, [10] luna vero quia sola ipsa sub sole est et caducorum iam regioni luce sua carenti proxima, lucem nisi de superposito sole qua resplendet habere non potuit, denique quia totius mundi ima pars terra est, aetheris autem ima pars luna est, lunam quoque terram sed aetheriam vocaverunt.[3]

Next a few things must be said concerning the order of the spheres, about which Cicero can be found to disagree with Plato by saying the sphere of the Sun is fourth of seven, that is, located in the middle; Plato places the Sun next above the Moon, that is, holding among the seven the sixth position down from the top. And the doctrine of the Chaldeans unites Archimedes to Cicero, while Plato has followed the Egyptians, progenitors of all the branches of philosophy, who considered the Sun to be positioned between the Moon and Mercury. They moreover grasped and made known to reason why the Sun was believed by so many to be above both Mercury and Venus. Nor have those who so opine strayed far from a semblance of what is true. Indeed, the following sort of thinking led to the belief in such a variant. From Saturn's sphere, which is first of the seven, all the way to the sphere of Jupiter, second from the highest, there is so great a distance of intervening space that the higher planet completes a course of the zodiac in thirty years while the lower does so in twelve. Further, the sphere of Mars stands so far from Jupiter as to run the same course in two years. Likewise Venus is so far below the realm of Mars that a year suffices it for coursing the zodiac. Now in fact the

[3] Macrobius (1970), pp. 73-5.

planet Mercury is so near Venus and the Sun so near Mercury that these three circle through their heavenly realm in the same interval of time, that is, in a year more or less. And so Cicero called these two coursers the companions of the Sun, because in the same interval they never withdraw far from each other. The Moon fell so far below these that it covered in twenty-eight days what they did in a year. Therefore among the ancients there has been no disagreement over the order of the three higher planets, which shown forth obviously and clearly by virtue of immense distance, nor disagreements over the realm of the Moon. The nearness of those three companions, Venus, Mercury, and the Sun, has confounded their ordering, but only for some authorities. For the explanation has not escaped the shrewdness of the Egyptians and is thus. The orbit along which the Sun travels is surrounded as an inferior by the orbit of Mercury; this latter orbit in turn the superior orbit of Venus contains, and it happens thus that these two planets, when traveling through the superior *vertices* of their orbits are thought to be located above the Sun, and when they pass easily through the inferiors of their orbits, the Sun is believed to be superior to them. Therefore, those who have said that these planetary spheres [of Mercury and Venus] are below the Sun have seen this during that course of the planets which sometimes, as we said, seems to be inferior; and this appearance is really more noticeable, for it can be seen more clearly then. When they occupy the superiors they are hidden more [quickly] by the Sun's rays. And so this latter conviction has gained strength, and the corresponding order of the planets has been accepted almost universally. Nevertheless, more perspicacious observation discerns a truer order, which, apart from the examination of the appearances, the following reasoning also recommends: that the Moon, which lacks a light of its own and borrows from the Sun, is necessarily subordinated to the source of its light. That the Moon has no light of its own, that all the other planets are seen by their own light, the following explanation accounts for: those planets above the Sun are located in that purest aether, in which everything whatever is naturally and intrinsically light (*lux*), which, complete with its fire, inclines toward the sphere of the Sun, so that the zones of heaven distant from the Sun are perpetually burdened by cold, as will be shown later on. Indeed, the Moon, since it alone is beneath the Sun and next to the nonluminous realm of transitory things, could have no light if not for the Sun above it, to which it shines back. And so because the lowest part of the whole universe is the Earth and the Moon is the lowest part of the aether, they call the Moon also an Earth but an aethereal one.[4]

[4]Eastwood (1982*a*), pp. 385-6.

3 CATALOGUE OF MANUSCRIPTS

No.	Library Reference	Century
Macr1	Aberystwyth NLW, 735C, f.4v	XI(in)
Macr2	Admont StiB, 782, f. 9v	XIII
Macr3	Admont StiB, 514, f.36r	XII(ex)
Macr4	Admont StiB, 514, f.53v	XII(ex)
Macr5	Admont StiB, 782, f.9r	XIII
Macr6	Avranches BM, 226, f.85r	XIII
Macr7	Avranches BM, 226, f.88r	XII/XIII
Macr8	Baltimore WAG, W.22, f.43v	XII
Macr9	Bamberg SB, Class. 38, f.27r	XI
Macr10	Basel UB, F.IV.31, f.25r	XIV(in)
Macr11	Berlin SB, lat. Oct.8, f.40r	XII
Macr12	Berlin SB, Phillipps 1784, f.7r	IX(1/2)
Macr13	Berlin SB, Phillipps 1833, f.36r	XI(in)
Macr14	Bern BB, 265, f.51v	XI
Macr15	Bern BB, 347, f.9r	IX(2/2)
Macr16	Bruxelles BR, 10053, f.161v	XIII
Macr17	Bruxelles BR, 10053, f.176v	XIII
Macr18	Bruxelles BR, 10146, f.135v	X(in)
Macr19	Cambridge (Mass.) Harvard HL, Typ.7, f.61r	XV(1469)
Macr20	Cambridge Trinity CL, R.9.23, f.43v	XII
Macr21	Cambridge UL, Gg.I.10, f.30r	XII
Macr22	Cambridge UL, Gg.I.10, f.33v	XII
Macr23	El Escorial RB, a.IV.13, f.81r	XIII
Macr24	El Escorial RB, a.IV.13, f.82v	XIII
Macr25	El Escorial RB, e.IV.24, f.45r	XII(m)
Macr26	Erfurt StB, Ampl. Q.351, f.12v	XII
Macr27	Erfurt StB, Ampl. Q.8, f.50v	XII(m)
Macr28	Eton Eton CL, 90, f.103v	XII(ex)
Macr29	Eton Eton CL, 90, f.106v	XII(ex)
Macr30	Firenze BML, Conv. Soppr. 444, f.33v	XII(2/2)
Macr31	Firenze BML, Conv. Soppr. 444, f.39r	XII(2/2)
Macr32	Firenze BML, Plut. 51.14, f.39v	XI(in)
Macr33	Firenze BML, Plut. 76.33, f.32v	XI
Macr34	Firenze BML, San Marco 287, f.19v	XI
Macr35	Firenze BML, Santa Croce 22 sin. 9, f.33r	XI
Macr36	Firenze BML, Santa Croce 22 sin.9, f.58v	XI

No.	Library Reference	Century
Macr37	Firenze BML, Strozzi 74, f.35v	XII
Macr38	Firenze BN, Conv. Soppr. J.II.49, f. 28r	XII
Macr39	Genève-Cologny FB, 111, f.14r	X(2/2)
Macr40	Göttingen UB, Oct. Philol. 115, f.81v	XII
Macr41	Karlsruhe LB, K.406, f.58r	XIII
Macr42	Kobenhavn KB, GKS 1909.4°, f.31r	XI
Macr43	Kobenhavn KB, NKS 218.4°, f.50v	XII
Macr44	Köln DB, 186, f.98v	IX
Macr45	Leiden UB, BPL 157, f.59v	XIII, XIV
Macr46	Leiden UB, BPL 168, f.32v	XII(2/2)
Macr47	Leiden UB, BPL 168, f.35v	XII(2/2)
Macr48	Leiden UB, Voss lat. Q.127, f.36r	XII
Macr49	Leiden UB, Voss. lat. Q.44, f.21r	XII(1/2)
Macr50	Leipzig UB, Rep. I.84, f.44v	XIII(in)
Macr51	Leipzig UB, Rep. I.84, f. 44v	XIII(in)
Macr52	London BL, Add. 11943, f. 27r	XI
Macr53	London BL, Add. 22815, f. 20v	XII
Macr54	London BL, Arundel 339, f. 135v	XIII(in)
Macr55	London BL, Add. 11943, f.27r	XI
Macr56	London BL, Add. 22815, f.20v	XII/XIII
Macr57	London BL, Arundel 339, f.135v	XIII
Macr58	London BL, Arundel 339, f.137v	XIII
Macr59	London BL, Cott. Faustina C.1, f.79v	XI(ex)
Macr60	London BL, Cott. Faustina C.1, f.81r	XI(ex)
Macr61	London BL, Egerton 2976, f.37 bis	XII
Macr62	London BL, Harl. 2467, f.55v	XV
Macr63	London BL, Harl. 2633, f.37r	XII
Macr64	London BL, Harl. 2652, f.31v	XII
Macr65	London BL, Harl. 2772, f.61v	XI
Macr66	London BL, Harl. 5433, f.39v	XV(1446)
Macr67	London BL, Roy. 13.A.XI, f.127r	XI/XII(1/2)
Macr68	London Inner Temple, Petyt 511.10, f.60r	XII(m)
Macr69	London Lambeth Palace, 342, f.149r	XII
Macr70	Los Angeles Getty Museum, Ludwig XII.4, f.12v	X(2/2)
Macr71	Los Angeles Getty Museum, Ludwig XII.4, f.22v	X(2/2)

No.	Library Reference	Century
Macr72	Los Angeles Getty Museum, Ludwig XII.5, f.120v	XIII(1/2)
Macr73	Milano BA, E.5 sup., f. 53r	XII(2/2)
Macr74	Milano BA, H.3 sup., f.26v	XII(1/2)
Macr75	München SB, clm 14353, f.107r	XI(in)
Macr76	München SB, clm 14436, f.45r	X
Macr77	München SB, clm 14619, f.29r	XII(1/2)
Macr78	München SB, clm 14663, f. 43v	XII(ex)
Macr79	München SB, clm 15738, f.197v	XV
Macr80	München SB, clm 18208, f.19r	XII
Macr81	München SB, clm 19471, f.34v	XII
Macr82	München SB, clm 19471, f.36r	XII
Macr83	München SB, clm 407, f.42r	XII
Macr84	München SB, clm 4612, f.79r	XII(2/4)
Macr85	München SB, clm 6362, f.62r	XI
Macr86	München SB, clm 6364, f.10v	X(2/2)
Macr87	München SB, clm 6369, f.37r	XI
Macr88	Napoli BN, V.A.11, f.24v	XII
Macr89	Oxford BoL, Auct. F.2.20, f.42v	XI(2/2)/XII(1/2)
Macr90	Oxford BoL, Auct. T.2.27, f.32r	X(ex)
Macr91	Oxford BoL, Canon. Class. lat. 257, f.21r	XIV(1383)
Macr92	Oxford BoL, Digby 23, f.52r	XII
Macr93	Oxford BoL, D'Orville 77, f.85v	XI(in)
Macr94	Oxford BoL, Selden Supra 25, f.194r	XII/XIII
Macr95	Oxford BoL, Selden Supra 26, f.71r	XII(2/2)
Macr96	Oxford Lincoln CL, lat. 27, f.131v	XII
Macr97	Oxford Lincoln CL, lat. 27, f.138r	XII(in)
Macr98	Oxford Lincoln CL, lat. 27, f. 131v	XII(in)
Macr99	Paris BNF, lat. 15170, f. 97v	XII(2/2)
Macr100	Paris BNF, lat. 7299, f. 71v	XI(in)
Macr101	Paris BNF, lat. 11123, f.47r	XII
Macr102	Paris BNF, lat. 15170, f.101v	XII(2/2)
Macr103	Paris BNF, lat. 15170, f.97v	XII(2/2)
Macr104	Paris BNF, lat. 16677, f.37v	IX
Macr105	Paris BNF, lat. 16680, f.43r	XII(2/2)
Macr106	Paris BNF, lat. 6365, f.17r	XI(in)
Macr107	Paris BNF, lat. 6367, f.1r	XIV
Macr108	Paris BNF, lat. 6367, f.2r	XIV

No.	Library Reference	Century
Macr109	Paris BNF, lat. 6370, f.61v	IX(1/2)
Macr110	Paris BNF, lat. 6371, f.12v	XI
Macr111	Paris BNF, lat. 6372, f.31r	XIV
Macr112	Paris BNF, lat. 6570, f.79v	XII(2/2)
Macr113	Paris BNF, lat. 6619, f.39v	XII(m)
Macr114	Paris BNF, lat. 6622, f.42r	XIII
Macr115	Paris BNF, lat. 6623, f.19r	XIII
Macr116	Paris BNF, lat. 6764, f.2v	XIII
Macr117	Paris BNF, lat. 7299, f.50v	XI(in)
Macr118	Paris BNF, lat. 7299, f.71v	XI(in)
Macr119	Paris BNF, lat. 7378A, f.79v	XIV
Macr120	Paris BNF, lat. 8677, f.149v	XV(m)
Macr121	Paris BNF, lat. 8677, f.150v	XV(m)
Macr122	Paris BNF, lat. 8677, f.156v	XV(m)
Macr123	Paris BNF, lat. 8677, f.158r	XV(m)
Macr124	Paris BNF, nal 454, f.52r	IX
Macr125	Praha SK, VIII.H.32, f.30r	XII/XIII
Macr126	Praha SK, VIII.H.32, f.52r	XII/XIII
Macr127	Praha-Hrad KM, H.2 (1053), f.45v	XIII
Macr128	Roma BVall, C 54, f.183v	XII(ex)
Macr129	Roma BVall, C 54, f.188v	XII(ex)
Macr130	Roma BVall, C54, f.183v	XII(ex)
Macr131	St. Florian StiB, XI.52, f.86r	XIII
Macr132	St. Florian StiB, XI.586, f.127r	XII
Macr133	Torino BN, D.V.38, f.50v	XII(2/2)
Macr134	Trento BC, 225, f.38v	XII/XIII
Macr135	Troyes BM, 804, f.218v	XI
Macr136	Utrecht UB, 811, f.23v	XII/XIII(in)
Macr137	Vaticano BAV, Ottob. lat. 1516, f.32r	XII/XIII
Macr138	Vaticano BAV, Ottob. lat. 1939, f.38r	XI(ex)
Macr139	Vaticano BAV, Palat. lat. 1341, f.78v	X(2/2)
Macr140	Vaticano BAV, Palat. lat. 1577, f.65v	XI(in)
Macr141	Vaticano BAV, Palat. lat. 274, f.52v	XII
Macr142	Vaticano BAV, Regin. lat. 1367, f.40v	XII
Macr143	Vaticano BAV, Regin. lat. 1439, f.72v	XII
Macr144	Vaticano BAV, Regin. lat. 1565, f.38v	XII(ex)
Macr145	Vaticano BAV, Regin. lat. 1751, f.31v	XII
Macr146	Vaticano BAV, Regin. lat. 1762, f.184r	IX(2/3)

No.	Library Reference	Century
Macr147	Vaticano BAV, Regin. lat. 1870, f.103v	XIII(ex)
Macr148	Vaticano BAV, Regin. lat. 1870, f.103v	XIII(ex)
Macr149	Vaticano BAV, Regin. lat. 1870, f.106v	XIII(ex)
Macr150	Vaticano BAV, Regin. lat. 1987, f.1r	XII
Macr151	Vaticano BAV, Vat. lat. 1545, f.36v	XV
Macr152	Vaticano BAV, Vat. lat. 1546, f.43v	XI(ex)
Macr153	Vaticano BAV, Vat. lat. 1546, f.45r	XI(ex)
Macr154	Vaticano BAV, Vat. lat. 1546, f.47r	XI(ex)
Macr155	Vaticano BAV, Vat. lat. 1546, f.47r	XI(ex)
Macr156	Vaticano BAV, Vat. lat. 1546, f.53v	XI(ex)
Macr157	Vaticano BAV, Vat. lat. 1546, f.56r	XI(ex)
Macr158	Vaticano BAV, Vat. lat. 1547, f.32v	XII(ex)
Macr159	Vaticano BAV, Vat. lat. 1548, f.15 bis	XI(ex)
Macr160	Vaticano BAV, Vat. lat. 3874, f.102r	XII
Macr161	Vaticano BAV, Vat. lat. 4200, f.73v	XII
Macr162	Vaticano BAV, Vat. lat. 5135, f.38v	XII(in)
Macr163	Vaticano BAV, Vat. lat. 5135, f.65v	XII(in)
Macr164	Vaticano BAV, Vat.lat. 5135, f.34r	XII(in)
Macr165	Vaticano BAV, Ottob. lat. 1516, f. 33v	XII-XIII
Macr166	Vaticano BAV, Palat. lat. 274, f. 52v	XII
Macr167	Vaticano BAV, Regin. lat. 1367, f. 40v	XII
Macr168	Vaticano BAV, Regin. lat. 1573, f. 48r	XI
Macr169	Vaticano BAV, Vat. lat. 1546, f. 47r	XI(ex)
Macr170	Vaticano BAV, Vat. lat. 3874, f. 102r	XII
Macr171	Vaticano BAV, Vat. lat. 5135, f. 34r	XI(ex)-XII(in)
Macr172	Venezia BN, VI.239, f.25v	XII
Macr173	Wien NB, cod. 12600, f. 51r	XII(ex)
Macr174	Wien NB, cod. 2269, f.201v	XI/XII
Macr175	Wien NB, cod. 806, f.176v	XIII
Macr176	Wolfenbüttel HAB, 153 Gud. lat. 4°, f.127v	XIII
Macr177	Wroclaw BU, R 69, f.63r	XIII
Macr178	Zürich ZB, Car.C.122, f.15v	X(2/2)/XI(1/2)
Macr179	Zwettl StiB, 389, f.54r	XII

4 CATALOGUE OF DIAGRAMS

The following codes and abbreviations are used for the list of attributes of the Macrobian diagram *Zodiacal Configuration*

1	planetary order of Caldeans (Venus and Mercury below Sun)
2	planetary order of Egyptians (Sun below Venus and Mercury)
3	outer planets and Moon in standard order: Sun, Mercury, Venus on intersecting circles within zodiacal framework
4	zodiacal framework contains non-Macrobian elements in planetary circles
a	arrangement of planetary order under one zodiacal sign
b	arrangement of planetary order under a succession of signs
marg	diagram appears in margin of text rather than in text space

The following codes and abbreviations are used for the list of attributes of the Macrobian diagram *Intersecting Circles*

marg	appears in the margin of the text
(number of) circles	the number other than three of intersecting circles

The following codes and abbreviations are used for the list of attributes of the Macrobian diagram *Concentric Circles*

1	Caldean planetary order (inner planets: Sun, Venus, Mercury, Moon)
2	Egyptian planetary order (inner planets: Venus, Mercury, Sun, Moon)
marg	the diagram appears in the margin of the text

Label	Diagram Type	Attributes
Macr28	Concentric circles	2, marg, 4 circles
Macr59	Concentric circles	2, marg
Macr78	Concentric circles	marg, no planetary names
Macr99	Concentric circles	marg
Macr103	Concentric circles	2, marg
Macr147	Concentric circles	2, marg, 4 circles
Macr154	Concentric circles	2, marg, 4 circles + Earth
Macr169	Concentric circles	2, marg

Label	Diagram Type	Attributes
Macr167	Concentric circles	1 (order Sun, Mercury, Venus), marg, 7 planets
Macr2	Intersecting circles	
Macr6	Intersecting circles	4 variants of non-concentric circles, marg
Macr21	Intersecting circles	marg
Macr24	Intersecting circles	end of text
Macr26	Intersecting circles	marg
Macr30	Intersecting circles	marg
Macr36	Intersecting circles	separated from text
Macr45	Intersecting circles	end of text, Earth placed so that 3 equal circles become a Capellan pattern
Macr47	Intersecting circles	marg
Macr49	Intersecting circles	marg
Macr50	Intersecting circles	in text of Calcidius
Macr51	Intersecting circles	
Macr53	Intersecting circles	marg
Macr54	Intersecting circles	5, marg
Macr56	Intersecting circles	marg
Macr57	Intersecting circles	5 circles, marg
Macr71	Intersecting circles	7 circles, apart from text
Macr73	Intersecting circles	follows text of *Timaeus*
Macr94	Intersecting circles	marg, Moon in central space
Macr96	Intersecting circles	marg
Macr98	Intersecting circles	marg
Macr116	Intersecting circles	precedes text
Macr117	Intersecting circles	center of each circle labeled as center of its planetary deferent
Macr128	Intersecting circles	marg
Macr130	Intersecting circles	marg
Macr133	Intersecting circles	precedes text, Earth and Moon in central section
Macr141	Intersecting circles	marg
Macr142	Intersecting circles	marg, Moon in central space
Macr148	Intersecting circles	marg, Earth in central space
Macr155	Intersecting circles	marg, Moon in central space
Macr160	Intersecting circles	follows text
Macr164	Intersecting circles	marg, unlabeled, Capellan type

Label	Diagram Type	Attributes
Macr165	Intersecting circles	4, marg, unlabeled
Macr166	Intersecting circles	marg
Macr170	Intersecting circles	order Mercury, Venus, Sun, follows text
Macr171	Intersecting circles	marg, unlabeled
Macr176	Intersecting circles	marg
Macr1	Zodiacal configuration	3, sequence Venus, Sun, Mercury, for inner planets
Macr3	Zodiacal configuration	1a
Macr4	Zodiacal configuration	2b + 2b
Macr5	Zodiacal configuration	1a
Macr7	Zodiacal configuration	1a + 2a
Macr8	Zodiacal configuration	2b + 2a
Macr9	Zodiacal configuration	1a
Macr10	Zodiacal configuration	2b
Macr11	Zodiacal configuration	1a
Macr12	Zodiacal configuration	1a
Macr13	Zodiacal configuration	4
Macr14	Zodiacal configuration	1a
Macr15	Zodiacal configuration	1a
Macr16	Zodiacal configuration	1a
Macr17	Zodiacal configuration	1a + 2a + 2b
Macr18	Zodiacal configuration	1a
Macr19	Zodiacal configuration	2b
Macr20	Zodiacal configuration	2b
Macr22	Zodiacal configuration	1a
Macr23	Zodiacal configuration	1a
Macr25	Zodiacal configuration	2b
Macr27	Zodiacal configuration	half destroyed
Macr29	Zodiacal configuration	1a
Macr31	Zodiacal configuration	1a
Macr32	Zodiacal configuration	1a + 2b
Macr33	Zodiacal configuration	1a + 1b
Macr34	Zodiacal configuration	1a
Macr35	Zodiacal configuration	1a + 2b
Macr37	Zodiacal configuration	1a, added exterior band for 12 months
Macr38	Zodiacal configuration	2a
Macr39	Zodiacal configuration	1a
Macr40	Zodiacal configuration	1a + 2b

Label	Diagram Type	Attributes
Macr41	Zodiacal configuration	1a + 1b
Macr42	Zodiacal configuration	illegible
Macr43	Zodiacal configuration	5 eccentric circles in planetary space, 7 planetary names on outer circle, arrangement b
Macr44	Zodiacal configuration	1a
Macr46	Zodiacal configuration	1b
Macr48	Zodiacal configuration	1a
Macr52	Zodiacal configuration	1b, 2b
Macr55	Zodiacal configuration	1b + 2b
Macr58	Zodiacal configuration	2b marg
Macr60	Zodiacal configuration	1a + 2a
Macr61	Zodiacal configuration	2a + 2b
Macr62	Zodiacal configuration	no planets listed
Macr63	Zodiacal configuration	2b + 2b
Macr64	Zodiacal configuration	1a
Macr65	Zodiacal configuration	2b
Macr66	Zodiacal configuration	1b
Macr67	Zodiacal configuration	1a + 1b
Macr68	Zodiacal configuration	1a
Macr69	Zodiacal configuration	2b
Macr70	Zodiacal configuration	2a
Macr72	Zodiacal configuration	2a
Macr74	Zodiacal configuration	1a
Macr75	Zodiacal configuration	1a
Macr76	Zodiacal configuration	1a
Macr77	Zodiacal configuration	2b
Macr79	Zodiacal configuration	1a + 2b + 2b
Macr80	Zodiacal configuration	2b + 2b
Macr81	Zodiacal configuration	1a
Macr82	Zodiacal configuration	planetary space has only one planetary level, arrangement b, marg
Macr83	Zodiacal configuration	1a
Macr84	Zodiacal configuration	1b
Macr85	Zodiacal configuration	1a
Macr86	Zodiacal configuration	1a
Macr87	Zodiacal configuration	1a
Macr88	Zodiacal configuration	1a

Label	Diagram Type	Attributes
Macr89	Zodiacal configuration	1a
Macr90	Zodiacal configuration	1a
Macr91	Zodiacal configuration	2a
Macr92	Zodiacal configuration	2a + 2b
Macr93	Zodiacal configuration	1a
Macr95	Zodiacal configuration	1a
Macr97	Zodiacal configuration	2b + 2b
Macr100	Zodiacal configuration	3
Macr101	Zodiacal configuration	1b
Macr102	Zodiacal configuration	1a + 2b + 2b
Macr104	Zodiacal configuration	1a
Macr105	Zodiacal configuration	1a + 2b
Macr106	Zodiacal configuration	1a
Macr107	Zodiacal configuration	2b + 2b
Macr108	Zodiacal configuration	1a
Macr109	Zodiacal configuration	1a
Macr110	Zodiacal configuration	1a
Macr111	Zodiacal configuration	2b + 2b
Macr112	Zodiacal configuration	1a + 2b
Macr113	Zodiacal configuration	2a
Macr114	Zodiacal configuration	2b + 2b
Macr115	Zodiacal configuration	1a
Macr117	Zodiacal configuration	1b
Macr118	Zodiacal configuration	3
Macr120	Zodiacal configuration	2b marg
Macr121	Zodiacal configuration	1a marg
Macr122	Zodiacal configuration	1b
Macr123	Zodiacal configuration	1b
Macr124	Zodiacal configuration	1a
Macr125	Zodiacal configuration	1a
Macr126	Zodiacal configuration	1a + 2b + 2b
Macr127	Zodiacal configuration	2b
Macr127	Zodiacal configuration	1a marg
Macr131	Zodiacal configuration	1a + 2b
Macr132	Zodiacal configuration	2b
Macr134	Zodiacal configuration	1a
Macr135	Zodiacal configuration	1a
Macr136	Zodiacal configuration	1a

Label	Diagram Type	Attributes
Macr137	Zodiacal configuration	2b
Macr138	Zodiacal configuration	1a + 1a + 2b
Macr139	Zodiacal configuration	1a
Macr140	Zodiacal configuration	1a
Macr143	Zodiacal configuration	1a
Macr144	Zodiacal configuration	1a
Macr145	Zodiacal configuration	2b + 2b
Macr146	Zodiacal configuration	1a
Macr149	Zodiacal configuration	1a
Macr150	Zodiacal configuration	1b + 1b
Macr151	Zodiacal configuration	1a + 1b
Macr152	Zodiacal configuration	1b + 1b marg
Macr153	Zodiacal configuration	1a marg
Macr156	Zodiacal configuration	1b
Macr157	Zodiacal configuration	1b
Macr158	Zodiacal configuration	inner planetary order: Mercury, Sun, Venus, Moon
Macr159	Zodiacal configuration	2b
Macr161	Zodiacal configuration	1a + 2b
Macr162	Zodiacal configuration	1b
Macr163	Zodiacal configuration	2b
Macr168	Zodiacal configuration	1a, 4
Macr172	Zodiacal configuration	1a
Macr173	Zodiacal configuration	1a, 4
Macr174	Zodiacal configuration	1a
Macr175	Zodiacal configuration	2a
Macr177	Zodiacal configuration	1a + 2b
Macr178	Zodiacal configuration	1a
Macr179	Zodiacal configuration	3, Mercury omitted, Mars replaces Mercury in intersecting circles

Chapter IV

CALCIDIAN DIAGRAMS

1 Lengths of Seasons Diagram

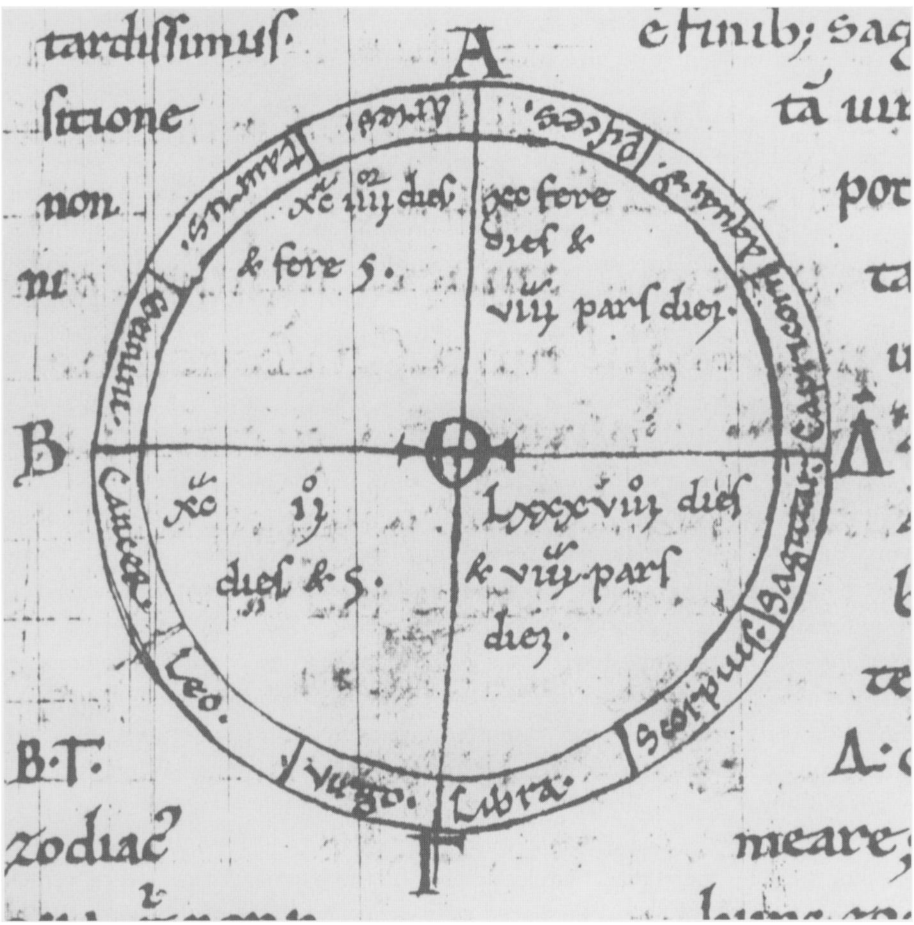

Figure IV.1. Lengths of seasons. Leiden Universiteitsbibliotheek, Ms. BPL 64, f.75v. Reproduced with permission of the Department of Western Manuscripts, University of Leiden.

1.1 DESCRIPTION

The description in the text and the diagrams in the manuscripts coincide well. The purpose of the diagram (Fig. IV.1) is solely to show that the four equal quadrants of the zodiac contain four unequal lengths of the year and what those lengths are. Initially the circle of the twelve signs is laid out, usually within a circular band, sometimes on the outside of a single circle. The four cardinal points ABΓΔ are set anticlockwise at 90° intervals, beginning with A at Aries 0° and at 12 o'clock. Two perpendicular diameters connect the pairs of points AΓ and BΔ. The letter Θ appears at the center point, where the diameters intersect.

1.2 TEXT AND TRANSLATION

Sit enim zodiacus circulus per ABΓΔ notas circumactus; cuius et universi mundi in medietate posita, iuxta quam stipatam manere dicimus terram, littera sit Θ, per quam lineae duae dirigantur bis secantes circulum in aequalia dimensa quattuor hae AΓ et BΔ, diametros utraque, intellegaturque A in exordio Arietis locatum, B in exordio Cancri, item Γ in regione Librae, Δ Capricorni. Ergo sol accedens ad A facere videtur aequinoctium vernum, ad B autem aestivam conversionem, item ad Δ autumnale aequinoctium, ad hiemalem conversionem. Aequales ergo partes mundi quattuor has ΓΔ, ΔA iniquis et imparibus temporibus videtur circumire, siquidem ex aequinoctio verno usque ad aestivam conversionem spatium caeli quod interiacet nonaginta fere et quattuor semis diebus et noctibus conflicit, ex conversione vero aestiva usque ad autumnale aequinoctium nonaginta et duobus semis diebus et noctibus pervenit, ab autumnali porro aequinoctio pergens ad brumalem conversionem octoginta et octo diebus pervenit et octaua parte unius diei, residuum item spatium, quod inter brumalem conversionem et vernum aequinoctium interiacet, nonaginta fere diebus et parte octaua diei conficit proptereaque omnem circuli meatum trecentis sexaginta et quinque diebus ac noctibus et parte quarta diei propemodum obire consensu omnium creditur: e regione Geminorum tardissimus, e finibus Sagittarii volucer, medius in transitione tam Virginis quam etiam Piscium.[1]

Let there be the zodiacal circle, defined by the letters ABΓΔ. Let its center and the center of the world be placed at Θ, where we say that the Earth always remains. Through this midpoint two diameters, the lines AΓ and BΔ, are drawn, cutting the circle into four equal spaces. The point A is understood to stand at the beginning of Aries, B at the beginning of Cancer, Γ likewise for Libra and Δ for Capricorn. Therefore the Sun arriving at A is seen to bring the vernal equinox, at B the summer solstice, again at Γ the fall equinox, and at Δ the winter solstice.

[1] Calcidius (1962), pp. 125-7.

Thus it appears to circle around through these four equal parts of the world, AB, BΓ, ΓΔ, and ΔA, in unequal and different time intervals. The part of the heavens from vernal equinox to summer solstice comprises about 94-1/2 days and nights; from summer solstice to autumnal equinox takes 92-1/2 days and nights; next, from autumnal equinox to winter solstice consumes 88-1/8 days; and then the remainder of the space, between winter solstice and spring equinox contains about 90-1/8 days. And thus, as all agree, the full passage of the circle of 365 and about $\frac{1}{4}$ days is achieved. In the sign of Gemini it [the passage] is slowest, swiftest within Sagittarius, midway in its change both in Virgo and in Pisces.[2]

2 SOLAR ECCENTRIC DIAGRAM

2.1 DESCRIPTION

Calcidius's explanation of the different lengths of the four seasons has, for moderns, a clear diagrammatic form. In the manuscripts, however, there are different medieval forms illustrating the text that describes the solar eccentric diagram. The following description adheres to a modern understanding of the text, which appeared in some but not most medieval diagrams.

As with the diagram defining the lengths of the four seasons, we begin with a circle of the zodiac that is divided by two perpendicular diameters and labeled similarly, having the points ABΓΔ at the four equidistant points of the zodiac that coincide with the cardinal points of the year. Within the zodiacal circle we draw a circle that represents the annual motion of the Sun. This solar circle encircles the center of the world Θ but with Θ removed from the center of the solar circle and arranged as follows. The center M of the solar circle is in the quadrant BΘA of the zodiacal circle. The solar circle cuts the four radii from Θ, proceeding anticlockwise from the radius ΘA, at the points EZHK. This arrangement will produce four solar arcs of four different lengths to correspond with the four different numbers of days already specified in the definitions of the lengths of the four seasons. The longest solar arc is EZ, corresponding to the length of 94-1/2 days from vernal equinox to summer solstice and lying under the zodiacal arc AB. The second solar arc, ZH, lies under BΓ and corresponds to 92-1/2 days. The third and shortest solar arc is HK, having 88-1/8 days. The final solar arc is KE with 90-1/8 days.

The lengths of lines in this diagram are not given; ratios of lengths of line segments are not given. The relative lengths of the four solar arcs are implied by the numbers of days for the lengths of the four seasons. The center M of the solar circle is said to be on a diameter NΞ that passes through Θ, making the distance

[2] Our translation.

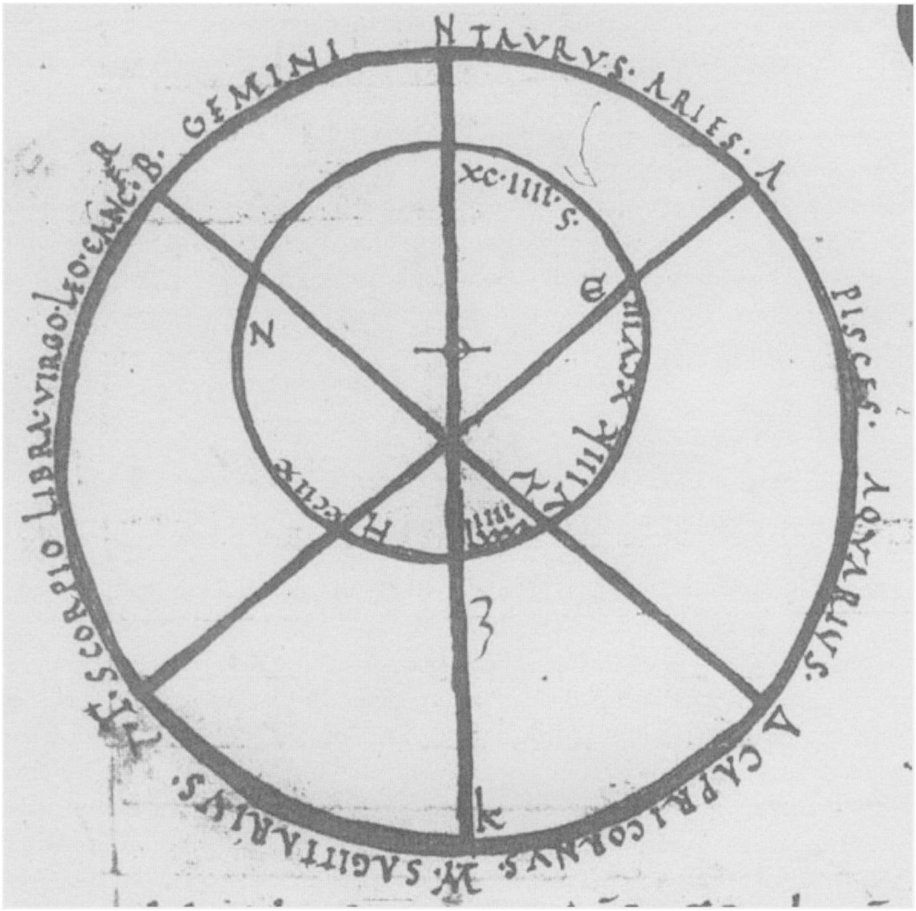

Figure IV.2. Solar eccentric. Köln Dombibliothek, Ms. 192, f.38v. Reproduced with permission.

NM greater than the distance ΘΞ. From this arrangement of the two circles and remembering that the Earth is at Θ, we can see that the Sun seems to move fastest through the arc HK, when closest to the Earth, and slowest through the arc EZ, when farthest from the Earth. The slowest point of solar motion as seen along the zodiacal circle occurs at 5-1/2° of the sign Gemini; the fastest at 5-1/2° of Sagittarius. The midpoints in solar speed appear in the signs Pisces and Virgo.

Some medieval diagrams approximate the above description; most do not. Among the divergent patterns, the following two are especially frequent. The first

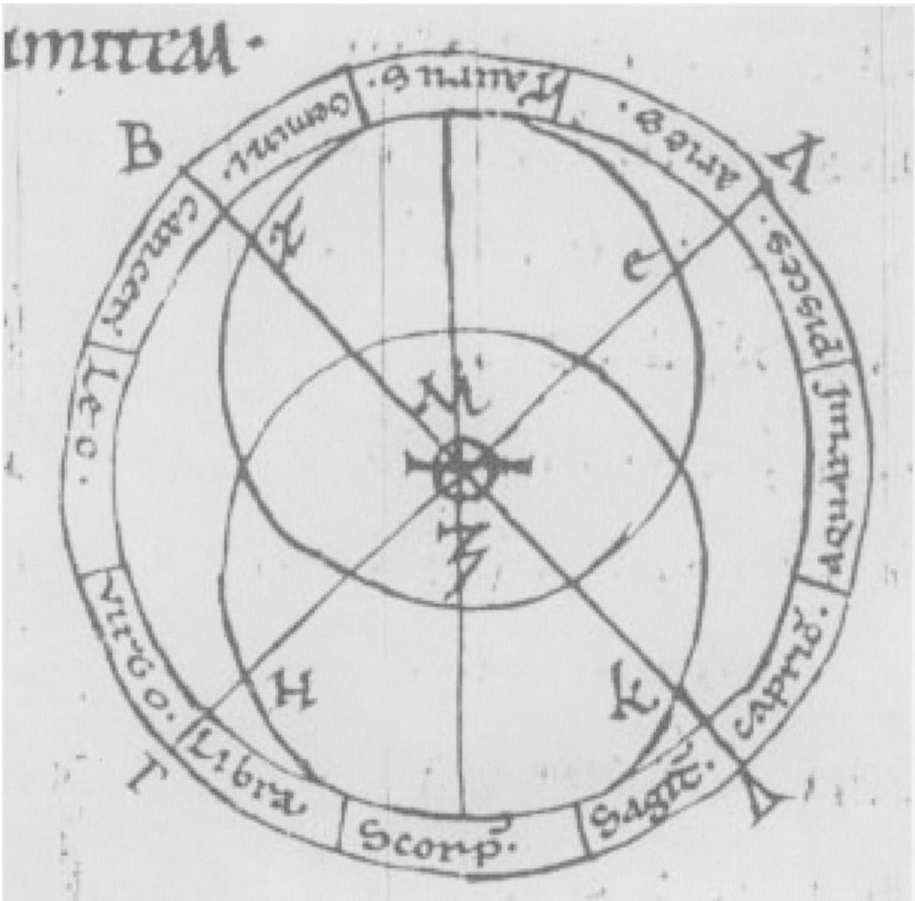

Figure IV.3. Solar eccentric. Leiden Universiteitsbibliotheek, Ms. BPL 64, f.77v. Reproduced with permission of the Department of Western Manuscripts, University of Leiden.

(Fig. IV.2) contains a solar circle, either eccentric or concentric with the zodiacal circle, and shows the outer, zodiacal circle divided about equally by three diameters, no two of which are perpendicular to each other. In this pattern the three diameters produce six roughly equal segments of the zodiacal circle.

The second divergent pattern also (Fig. IV.3) has three diameters, two of which may or may not be perpendicular to each other, within the zodiacal circle. Two equal intersecting circles, one of which has its centerpoint marked by the letter M,

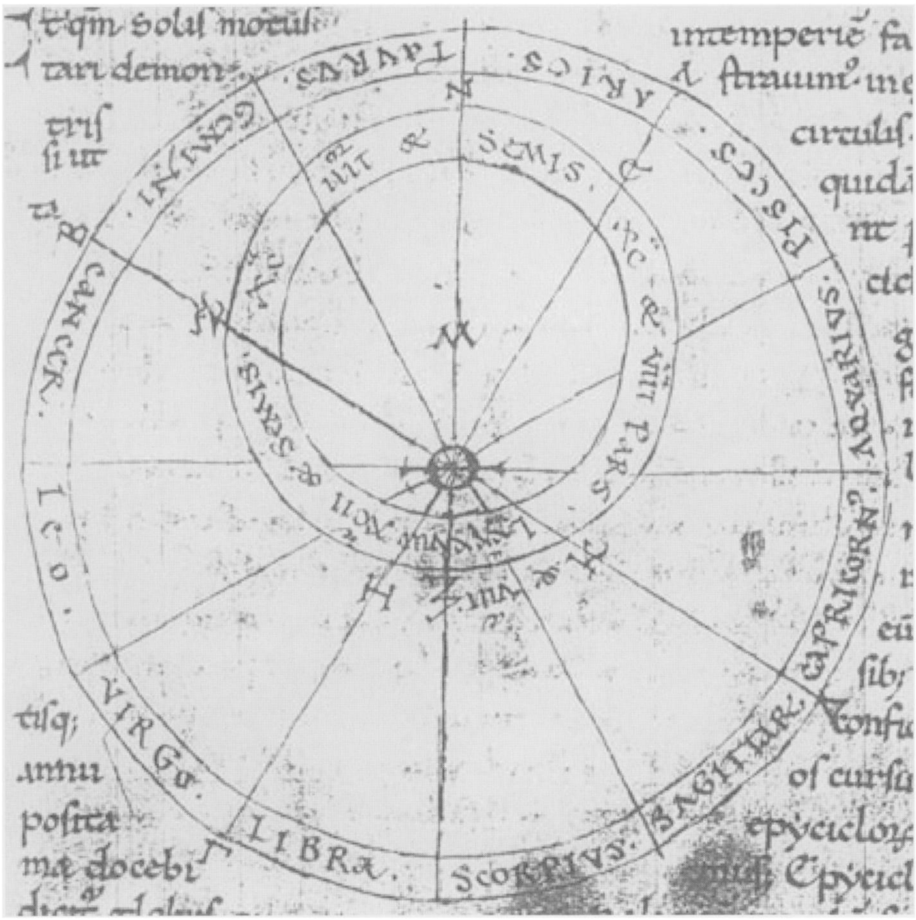

Figure IV.4. Solar eccentric: corrected version. Leiden Universiteitsbibliotheek, Ms. BPL 64, f.76v. Reproduced with permission of the Department of Western Manuscripts, University of Leiden.

appear within the zodiacal circle. In each of these divergent patterns the placement of some letters used by Calcidius to designate certain points may fail to follow his designations. Diagrams that seem essentially correct may omit or emphasize some aspects of the diagram, such as one (Fig. IV.4) that moves the center M of the solar circle very far from Θ in order to emphasize the differences in the lengths of the four solar arcs.

2.2 TEXT AND TRANSLATION

Fieri tamen non potest, ut contra naturam suam divinitate praeditam faciant aliquid vel patiantur inordinatum. Ex quo apparet per suum circulum et solem et ceteras stellas meantes aequabiliter et ordinate nobis e regione terrae spectantibus videri per ΑΒΓΔ circulum, qui est non solstitialis sed zodiacus, meare.

LXXIX. Quia igitur non per hunc zodiacum circulum sol, sed per alium solstitialem qui est eius proprius incedit, siquidem utriusque circuli punctum unum et idem esset in Θ, eadem ratione divisus solstitialis, qua zodiacus, in isdem vitiis et iniquitatibus inveniretur eodemque modo ΑΒΓΔ circuli partes aequales quattuor pluribus has, paucioribus alias obiret diebus. Sed si haec contra naturam siderum falso putare homines ratio monstraverit, certe perspicuum erit illius globi per quem sol movetur punctum in Θ non esse. Ergo circulus solis vel intra se continebit Θ, sed non ut punctum vel medietatem, vel per idem Θ transiet vel excludet omnino a gremio suo. At enim per Θ, id est terram, ire solem impossible est, conflagrabunt enim terrena solis ardoribus semperque solis globo superiore existente dies erit perpetua nec ei succedet nox, numquam scilicet mergente sole. Superest igitur, ut Θ vel intra ambitum solstitialis circuli sit vel extra; utrumque enim assumptum rationem habere monstrabitur. Quae quidem res inter mathematicos disceptationem creavit, siquidem alii sphaeris eccentris, id est quae terram intra se contineant quidem sed non ut punctum suum, vehi planetas asserunt, alii epicyclis potius, hoc est a terra separativis nec imminentibus ei globis. LXXX. Sit igitur solstitialis eccentrus circulus EZHK et habeat punctum sub EZ ambitu in medietate, scilicet ubi est M. Hoc igitur circulo in trecentas sexaginta quinque partes et partem quartam unius portionis diviso ad earundem partium exaequationem EZ quidem ambitus nonaginta quattuor semis portionibus continebitur, EH vero nonaginta duum semis erit partium, item HK octoginta et octo partes habebit et unius partis octavam, residuus ambitus KE ex nonaginta constabit partibus et octava unius partis. Necesse est itaque, ut, cum sol accedat ad eam partem in qua est E, nobis in puncto agentibus mundi totius Θ, id est terra, et inde quoad possumus intuentibus super A tunc ferri videatur, cum illa regio non solstitialis circuli sed zodiaci sit multo altioris summitas, ad quam visus noster non potest pervenire. Atque ita per EZ ambitum means aequabiliter, qui ambitus tribus ceteris maior est, pluribus ut necesse est diebus maiorem ambitum conficiens ubi ad Z pervenerit, ad B pervenisse videbitur, et tamquam AB peragrato ambitu aequalem quartam partem zodiaci circuli pluribus, quam ratio aequabilitatis exigit, diebus obisse creditur rursumque ZH ambitu sui circuli secundae magnitudinis peragrato aequabiliter diebus nonaginta duobus semis—tot enim partium est idem ambitus —ubi ad H pervenerit, videbitur nobis ad Γ pervenisse et ΒΓ ambitum velut aequalem priori paucioribus diebus emensus, eodemque modo HK minimum

ambitum lustrans, utpote qui sit in octoginta octo partibus et octaua, ubi totidem diebus obierit perveneritque ad K, e regione Θ spectantibus videbitur quidem ferri supra Δ, putabitur autem ΓΔ ambitum aequalem ceteris paucioribus diebus obisse; similique erroris perseverantia KE ambitu emenso nonaginta diebus et octava parte iuxta numerum portionum repraesentatusque demum in E finito anniversario anfractu ΔA ambitum putatur emensus aequalem ceteris iniquo et impari gressu nec in E exordium sui circuli repraesentatus sed in A alieni, id est zodiaci, circuli summitatem. Quod si duum circulorum, id est maioris zodiaci et minoris solstitialis eccentri, duo puncta coniungantur et fiat MΘ, deinde per hanc ducta perexeat NΞ linea, quia EZHK circuli punctum et medietas est M et Θ ABΓΔ circuli punctum et medietas est, aequales erunt lineae NM, MΞ. Maior igitur est NM linea quam ΞΘ, multo ergo maior NΘ quam ΘΞ. Cum ergo sol per N feretur longius a terra remotus, id est a Θ, minor nobis videbitur e longinquo, etiam tardior, quod fit iuxta quintam semis fere partem Geminorum; cum vero per Ξ feretur proximus terrae, maior putabitur velociorque intuentibus, quod demum fit iuxta quintam semis partem Sagittarii; mediae vero tam staturae quam velocitatis, cum aut Pisces aut Virginem transiet.[3]

Yet it cannot be that, contrary to their aforesaid nature in divinity, they [the planets] do or experience anything disordered. Whence it seems that both the Sun and the other planets, while moving uniformly and in good order along their own circle, appear to us, observers on the Earth, to move along ABΓΔ, which is not the solar but the zodiacal circle.

c. LXXIX. Wherefore the Sun moves, not along this zodiacal circle but along another, solar circle, which is exclusively its own. If, in fact, the center of each circle were in Θ, we would discover by the same reasoning the divisions of the solar circle like the zodiac into the same partitions and inequalities, and in the same way the Sun would travel the four equal parts of the circle ABΓΔ, some in more days, others in fewer days. But if this reasoning has showed that men have falsely supposed what is against the nature of the stars, surely it will be clear that the center of this circle along which the Sun is moved is not in Θ. Therefore the circle of the Sun will either contain Θ, but not as its center, or pass through that same Θ, or completely exclude it in every sense. And indeed it is impossible for the Sun to pass through Θ, for earthly things would burn up from the powers of the Sun, and, with the body of the Sun always above us, there would be constant day and never night, for the Sun would never set. And so it remains that Θ should be either within or outside of the Sun's circle; either assumption will be shown to have

[3] Calcidius (1962), pp. 127-30.

good reason. Indeed this situation [of the two alternatives] created a disagreement among the mathematicians so that, whereas some claimed that the planets are moved on eccentric circles, which encircle the Earth but not as their center, others preferred epicycles, which are circles [fully] separate from the Earth and not near it.

c. LXXX. Let there be then the eccentric solar circle EZHK, having its center in the middle of the arc EZ, at M as can be seen. With this circle divided into 365-1/4 days, of this sum the arc EZ contains 94-1/2 days, ZH [ed. Waszink incorrectly reads EH] is 92-1/2 days, HK has 88-1/8 days, and the remaining arc KE consists of 90-1/8 days. And so when the Sun reaches that point marked by E, it is necessary that we, being on the Earth at the centerpoint of the world, and looking from there, insofar as we are able, towards A, then it [the Sun] seems to be there [at A], although that place is not at the solar circle but at the distance of the much higher zodiac, to which our visual power cannot reach. And thus as [the Sun] moves uniformly along the arc EZ, which is larger than each of the other three arcs, so that in necessarily more days completing a longer arc it will reach Z, it will seem to have reached B. And after traversing the arc AB, it [the Sun] will be thought to have gone through exactly one-fourth of the zodiacal circle in more days, as the reason of uniform motion requires, and, again, traversing uniformly the arc ZH of its [solar] circle, the second magnitude, in 92-1/2 days—this same arc is composed of just so many days—when it [the Sun] will arrive at H, it will appear to us to have reached Γ. And having traveled through the [zodiacal] arc BΓ, equal to the previous one, in fewer days, in the same way illuminating the smallest [solar] arc HK, so that in 88-1/8 days, where in just this number of days it will travel and arrive at K, from the position of Θ it will seem to observers to be at Δ, and it will be judged to have covered the equal [zodiacal] arc ΓΔ in this remaining smaller number of days. And in continuation of the same misunderstanding, with the arc KE traveled in 90-1/8 days and [the Sun] represented [in the diagram] distinctly at E , the annual orbit being completed, it [the Sun] is considered to have traveled the arc ΔA, which is equal to those others [of the zodiac], in an unequal time interval, nor is it represented [to our vision] in E as the completion of its circle but in A, the height of the farther, zodiacal circle. But if the two centers of the two circles, that is the larger zodiacal circle and the smaller eccentric solar circle, are conjoined and make [the line] MΘ and then extend beyond as the line NΞ, since the center of circle EZHK is M and Θ is the center of circle ABΓΔ, the lines NM and MΞ are equal. Accordingly line NM is greater than ΞΘ, and so much more therefore is NΘ than ΘΞ. Thus when the Sun passes through N, farther from the Earth at Θ, it will appear smaller to us at a distance and likewise slower, which will occur at about 5-1/2 degrees [or days] into Gemini. And then when it passes

through Ξ close to the Earth, it will be judged larger and swifter to viewers, which then occurs at 5-1/2 degrees [or days] into Sagittarius. The midpoints in both size and speed will be when it passes through either Pisces or Virgo.[4]

3 SOLAR EPICYCLE DIAGRAM

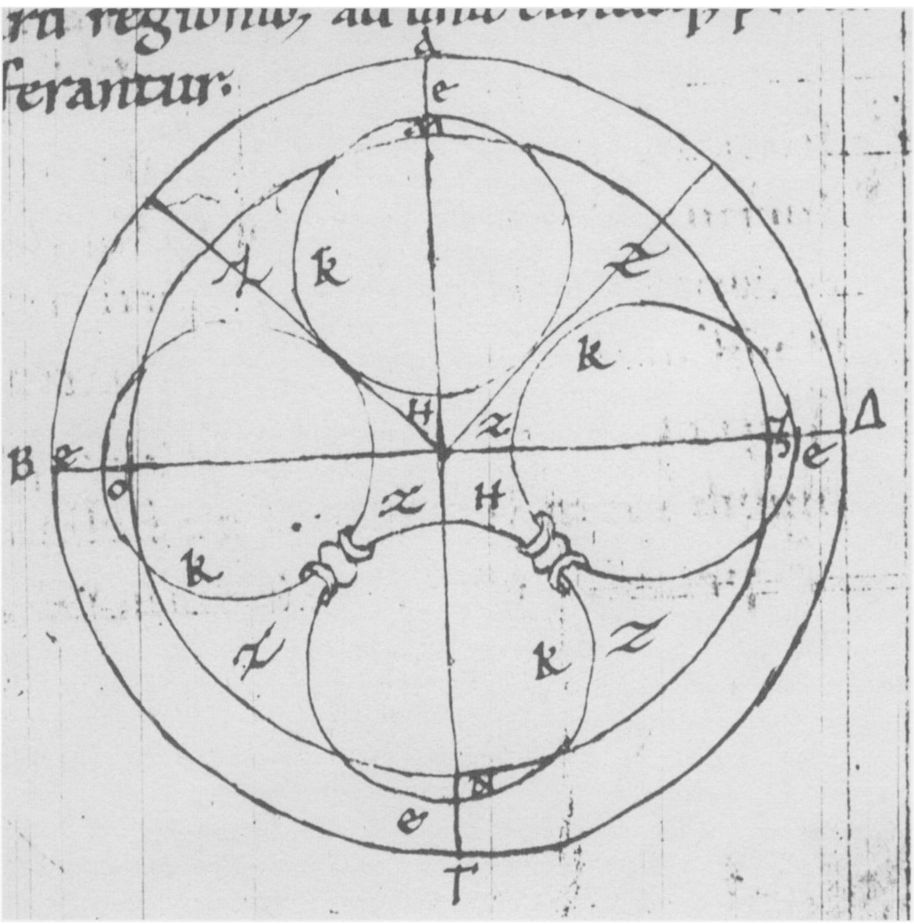

Figure IV.5. Solar epicycle. Leiden Universiteitsbibliotheek, Ms. BPL 64, f.78r. Reproduced with permission of the Department of Western Manuscripts, University of Leiden.

[4]Our translation.

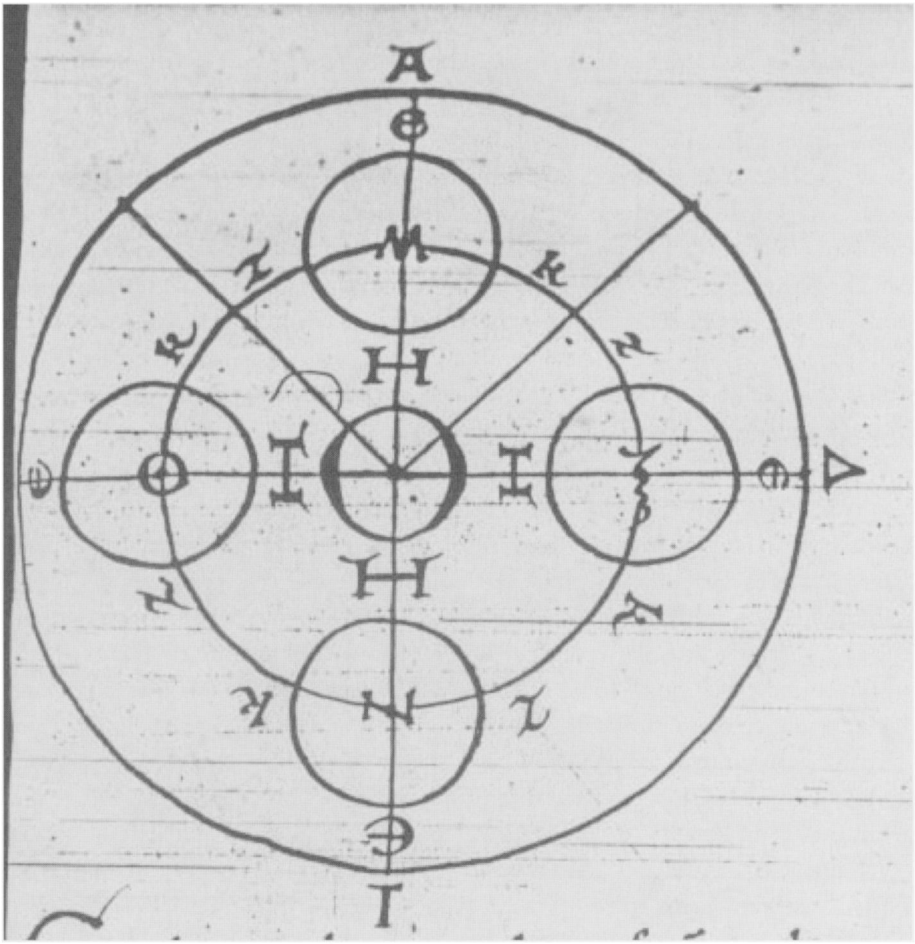

Figure IV.6. Solar epicycle: corrected version. London British Library, Ms. Add. 15293, f.23r. By permission of the British Library.

3.1 DESCRIPTION

An epicycle is a circle whith a center that is fixed on and revolves around the periphery of another circle at a uniform speed. The epicycle itself will rotate at its own uniform speed. Manuscript diagrams for this topic are recognizably related to each other, but the details of the epicyclic circles vary and suggest some difficulty in the understanding by early medieval scholars of these combinations of circular motions. Calcidius states that the motions of the circles are uniform, although

his description omits some potentially useful elements, such as the division of the epicycle into four equal quadrants; he does this explicitly only for the deferent circle. His definition of an epicycle is extremely general.

The geometrical framework is simple. The same zodiacal circle ΑΒΓΔ, ordered anticlockwise, as used in the explanation by an eccentric circle appears again here. The Earth is at the center Θ. Concentric with the zodiacal circle is the deferent circle ΜΟΝΞ (anticlockwise). The epicyclic circle has its center initially at M. The periphery of the epicycle is labeled anticlockwise ΕΖΗΚ. The rotation of each of these three circles is specified. ΑΒΓΔ rotates daily in a clockwise direction. ΜΟΝΞ rotates with the planetary orbital speed—once a year in the case of the Sun—anticlockwise. The epicycle ΕΖΗΚ rotates at a speed specific to the planet, in this case, for the Sun, once a year clockwise.

With the motion of the epicycle's center on the deferent from M to O, the epicyclic circle is oriented so that E remains outermost and toward the zodiacal point B. The Sun, located on the epicycle initially at E, rotates 90° to the point K, which is the uppermost point on the epicycle when its center is at O. This combination of motions continues from quadrant to quadrant through the year, at the end of which the solar epicycle will return to M and the Sun on the periphery of the epicycle will return to point E. But as the annual motion of the Sun occurs, the appearance from the Earth, at the center of the deferent and zodiacal circles, is that the Sun moves faster from K to H and H to Z than it moves from E to K and Z to E. This appearance of varying speed can be understood by noticing that from E to K and from Z to E the Sun seems to move slower than the center of the solar epicycle from M to O and from Ξ to M; conversely from K to H and from H to Z the Sun seems to move faster than the center of the epicycle from O to N and from N to Ξ. And the Sun at H is closest to the Earth and at E is farthest from the Earth during the annual motion. All this is as seen from the Earth, and the motions of the circles remain uniform.

3.2 TEXT AND TRANSLATION

LXXXI. Et quoniam solis motus intemperiem falso putari demonstravimus in eccentris circulis, nunc si, ut quidam putant, per epicyclos globos fertur, nihilo minus moderatis eum gressibus temperatisque conficere annuos cursus exposita epicyclorum forma docebimus. Epicyclus dicitur globus qui per aliquem circulum fertur. Sit igitur etiam nunc zodiacus circulus quem limitant notae ΑΒΓΔ, solstitialis vero excludens zodiaci circuli punctum, id est ΕΖΗΚ, habens ipse proprium punctum M, et a puncto quidem Θ, intervallo autem M describatur circulus ΜΟΝΞ, et ΕΖΗΚ epicyclus intellegatur cum universi mundi vertigine rapi similiter ut ceteri ignes ab oriente in occidentem raptatu cotidiano, ferri tamen naturaliter adversum

totius mundi volatum solque rursus in eodem epicyclo constitutus iuxta totius mundi conversionem moveri. Ergo EZHK epicyclus per descriptum MONΞ circulum naturali motu means contra quam movetur totius mundi raptatio moderate et aequabiliter anni spatio cursum istum conficiat solque item in hoc eodem epicyclo constitutus epicycli quidem sui motui contrarium motum moliatur, mundi vero totius coimtatum sequatur. Ibit ergo EZHK epicyclus per MONΞ circulum gradiens et, cum pervenerit ad O litteram, quartam mundi partem obibit. Tunc sol ab E ad K perget; erit ergo sol, ubi est O littera, nobis tamen a terra, id est Θ, spectantibus directa visus acie videbitur esse apud notam B. Ita, cum quartam confecerit mundi partem, minorem quartam confecisse videbitur. Ac rursum idem epicyclus a regione O litterae profectus perveniat ad N, et sol a K ad H perget; erit, ubi est N, nobis tamen directo visu intventibus videbitur esse ubi est Γ littera. Ita, cum aequalem quartam mundi partem confecerit a littera B usque ad Γ litteram, maiorem quartam citius et incitatius videbitur peragrasse. Rursum idem epicyclus conficiat aliam mundi aequalem partem, id est NZ, sol quoque item ut in prioribus ab H ad Z pergat; erit, ubi est Ξ, nobis autem videbitur ubi est Δ littera. Ita, cum aequalem quartam mundi partem peragraverit, maiorem peragrasse putabitur ΓΔ zodiaci circuli. Residuum demum quadrantem ΞM idem obeat epicyclus; cum pervenerit ad E repraesentatus post annum loco suo, videbitur esse tunc sol ubi est A et putabitur zodiaci circuli obrepsisse seimtam ΔA.

LXXXII. Qua ratione palam fit etiam secundum epicycli motum ea quae videntur nobis aliter quam reapse fiunt videri; tardior enim et minor visu videtur sol, cum velut in Geminis erit, maximus vero et incitatissimus, cum velut in Sagittario. Nec immerito; quippe EZHK epicyclo moto per MONΞ circulum sol ab E ad K pergens contra quam fertur epicyclus suus moram faciens tardius ad O deferetur tardiusque MO obibit ambitum multoque tardius zodiaci circuli AB regionem obisse existimatur, et rursum epicyclo supra dicto moto ad ON ambitum sol demum a K ad H pergens concurrere videbitur mundi circumactioni et adiutus ab ea propere et citius obire zodiaci quadrantem. Eodemque modo epicyclo moto per NΞ ambitum sol demum ab H ad Z pergens tam quam praecurrens epicycli sui motum praecipitare cursum per zodiacum videtur rursumque eodem epicyclo moto per ΞM ambitum sol a Z ad E pergens contra quam fertur epicyclus suus moram faciens tardius ad M deferetur tardiusque M obibit quadrantem multoque putatur tardius ΔA zodiaci circuli quadrantem peragrasse. Sic et epicyclus anno vertente conficiet cursum suum et sol naturalem estque in solis circuitu maximum intervallum a Θ ad E, id est, a terra ad summum limitem solstitialis epicycli, mini-

mum vero ad eiusdem infimum limitem.[5]

LXXXI. Since we have shown that the motion of the Sun is wrongly considered disordered in eccentric circles, now if, as some persons maintain, it occurs on epicyclic circles, we shall explain by means of epicycles that it accomplishes the annual circuits by no less ordered and constant movements. A circle that is carried on a circle is called an epicycle. So let there be a zodiacal circle defined by the letters ΑΒΓΔ, and outside the center of the zodiacal circle a solar [circle] EZHK, having its own center M, and from the center Θ at the distance of M is described the circle MONΞ, and the epicycle EZHK is understood to be carried along like the rest of the luminaries with the turning of the world, [or the celestial sphere,] in daily rotation from east to west. At the same time it [the epicycle] is carried naturally against the turning of the celestial sphere, and the Sun on this epicycle is moved back against the rotation of the heavens. Therefore the epicycle EZHK, moving by a natural motion along the defined circle MONΞ against the rotation of the celestial sphere, regularly and uniformly pursues its path in the space of a year, and the Sun on this epicycle undertakes the contrary motion of the epicycle's motion [around MONΞ] and follows [the sense of rotation of] the celestial sphere. Thus the epicycle EZHK will advance through the circle MONΞ, and on reaching the letter O will have traveled one-fourth of the way around the zodiac. At the same time the Sun passes from E to K. The Sun [on its epicycle] will be where the letter O is located, which to us on the Earth, at Θ, looking along a direct line of sight, will appear to be at the letter B. So when it has covered a fourth part of the zodiac [from M to O], it [the Sun] will seem to have covered less than a fourth (literally, a smaller fourth). Next the epicycle progresses from the letter O to N, and the Sun reaches H. It will be where N is, which to us, perceiving by a direct line of sight, will seem to be where the letter Γ is. And so, when it has completed an equal fourth portion of the zodiac from the letter B to the letter Γ, it will seem to have covered a larger fourth [from K to H] more quickly and more violently. Once again, the epicycle covers another equal fourth part of the circle, that is NΞ, and, in the same manner as before, the Sun proceeds from H to Z. It will be where Ξ is, which by us will be seen where the letter Δ is. And so, when it has traveled an equal fourth portion of the heavens, it will be assumed to have covered the larger [fourth] ΓΔ of the zodiacal circle. Finally, the epicycle passes over the remaining quadrant ΞM. When it reaches E, repositioned in its [original] place after a year, the Sun will then appear to be at A, and it will be assumed to have moved over the [zodiacal] path ΔA.

[5] Calcidius (1962), pp. 131-4.

LXXXII. This reasoning shows clearly how, through epicyclic motion, it happens that the phenomena are made to seem to us other than they really are. The Sun looks to be slower and smaller to our eyes when in Gemini and largest and swiftest when in Sagittarius. And not without reason, for by the epicyclic motion EZHK through the circle MONΞ, the Sun, passing from E to K more slowly along its path by rotating contrarily [against the epicycle], is moved to O and will travel the course of MO more slowly and is perceived to have covered the section AB of the zodiacal circle much more slowly. And once again by the same epicyclic motion along ON, the Sun, finally reaching from K to H, will be seen to accord with the rotation of the celestial sphere and, aided by it, to cover the quadrant of the zodiac hastily and quickly. And in the same way by the epicyclic motion on the path NΞ the Sun finally reaches from H to Z just as the motion of its epicycle is seen to hasten through the zodiac, and again, by the same epicyclic motion along the path ΞM, the Sun proceeds from Z to E as the epicycle [continues to] rotate contrary to its path through the heavens, and the Sun is moved to M more slowly and will travel the quadrant ΞM more slowly and is perceived to have covered much more slowly the quadrant ΔA of the zodiacal circle. And thus the epicycle in the course of a year completes its path, and the Sun has its greatest distance from Θ at E, that is, from the Earth to the outermost point of the solar epicycle, and its minimum distance at the innermost point [H] of the epicycle.[6]

4 GENERIC EPICYCLE DIAGRAM

4.1 DESCRIPTION

The manuscript diagrams for the generic epicycle (Fig. IV.7) follow generally the description of Calcidius's text. The most common divergence from the text's description is a failure of the radii tangent to the epicycle to be, in fact, tangent. Calcidius's account here would not be clear to a reader not already familiar with such a diagram. The purpose of the diagram is to identify the forward and retrograde arcs of the epicycle as well as the stationary points of the planet on the epicycle. The zodiacal circle and the Earth at its center are specified first. The epicyclic circle EZH is then presented, but the text requires a preexisting diagram and simply discusses the motion of points on the diagram. The three points labeling the epicycle only become clear as the description proceeds, the points Z and H being the points of tangency with the two radii drawn to the zodiacal circle and the point E being between the zodiacal point A and the center M of the epicycle along a radius from the Earth through M to A. Once this figure is recognized, the reader can follow Calcidius's account of epicyclic motion, which he applies here to

[6]Our translation.

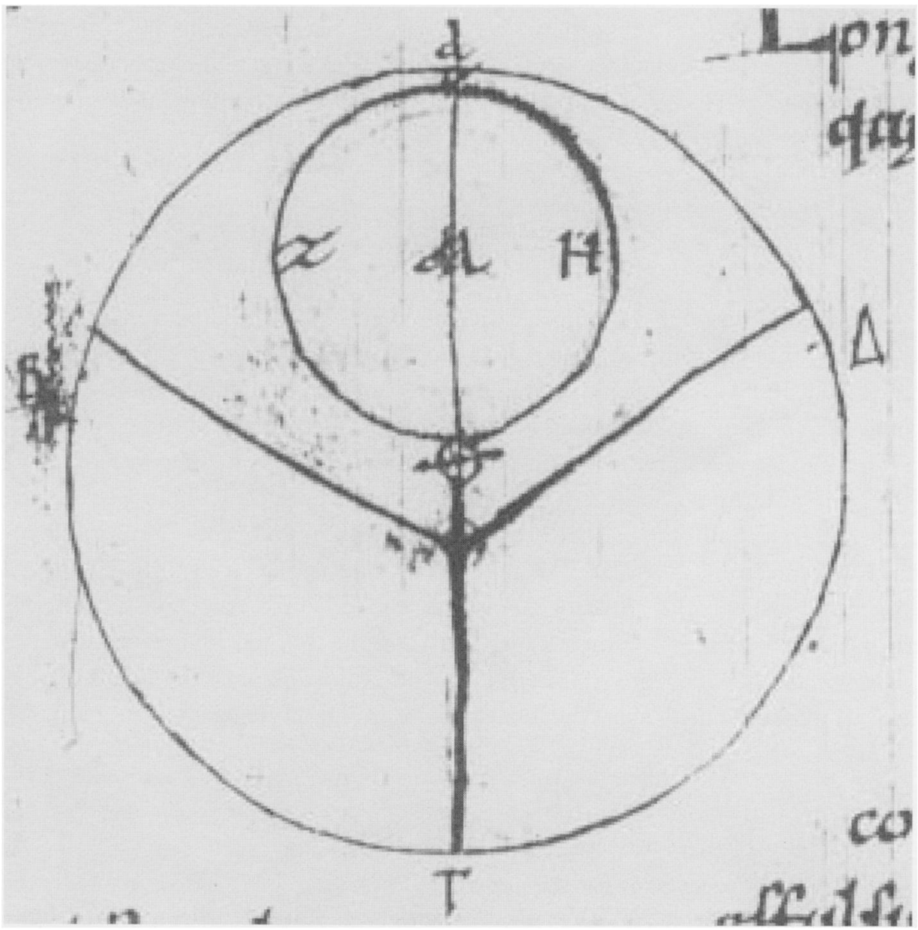

Figure IV.7. Generic epicycle. Leiden Universiteitsbibliotheek, Ms. BPL 64, f.79r. Reproduced with permission of the Department of Western Manuscripts, University of Leiden.

any planet and gives no specifics of planetary motion. The epicycle here is fixed and does not move around the zodiac. The epicycle only rotates, with its motion in the same sense as the celestial sphere, from east to west, showing the motion of a planet on its periphery. Calcidius points out the two locations, or regions, of planetary station in two very small arcs, including the tangent points H and Z. He then labels the passage from Z through E to H as the proper motion of the planet

on the periphery of the epicycle and the passage from H to Z as the retrograde motion of the planet. He continually reminds the reader that the planetary motions are seen against the background of the zodiac rather than directly on the epicyclic circle.

4.2 TEXT AND TRANSLATION

LXXXV. Sequitur ut, quoniam videntur quaedam nobis earum modo stare in progressu, modo regradari et interdum praecurrere certa signa zodiaci circuli, interdum remanere ac relinqui, quae causa sit huius imaginis consideretur. Sit ergo zodiacus circulus ABΓΔ, cuius punctum in medietate Θ, epicyclus autem erraticae cuiuslibet stellae EZH, cuius item punctum in medietate sit littera M, per quam medietatem velut axem proprium feratur idem epicyclus cum stella in semet locata zodiaci circuli pari motu, hoc est ab oriente in occidentem. Agantur etiam e regione Θ obliquae duae lineae stringentes utrimque extremos ambitus epicyli ΘZB—ΘHΔ, perque epicycli punctum M ducatur in altum linea ΘMA. Ergo stella cum erit in Z, nobis e terra directo visu spectantibus videbitur consistere in regione zodiaci, in qua est B, et cum ZE lustraverit ambitum, putabitur zodiaci BA ambitum peragrasse et ad praecedentia signa versum progressa esse. Similiter EH ambitu lustrato videbitur AΔ zodiaci ambitum obisse et ad praecedentia versum signa nunc festinasse. Rursum HZ regione peragrata videbitur nobis per AΔ ad B demum repedasse obvia facta signis sequacibus proptereaque esse regradata. Cumque non multum spatii a Z recedet, etiam nunc tamquam in B diu in eodem loco morari putabitur; at vero cum recesserit longius transitoque E limite ad H pervenerit, rursum consistere in Δ et praecedentia signa existimabitur praecurrisse recedensque ab H longius per HZ ad B repedasse.[7]

LXXXV. Since certain stars appear to us at times to halt in their forward motion, at times to retrogress and sometimes to run ahead to certain signs of the zodiac, sometimes to hold back and give up [some space], we may consider what the cause of this phenomenon might be. Then let there be the zodiacal circle ABΓΔ, whith center Θ, and EZH the epicycle of some planet, with its center at M, around which the epicycle rotates, with the planet fixed on it, in the same direction as the celestial sphere, that is, from east to west. There are drawn from Θ two lines tangent on both sides of the epicycle, ΘZB and ΘHΔ, and through the center M of the epicycle a vertical line, ΘMA. Thus when the planet is in Z, to us looking by rectilinear vision it seems to be in the part of the zodiac where B is, and when it illuminates the path ZE it is considered to have moved through the zodiacal arc AΔ and to have progressed in the direction of the preceding signs. Similarly when it has blazed through the arc EH it appears to have traveled the

[7] Calcidius (1962), pp. 136-7.

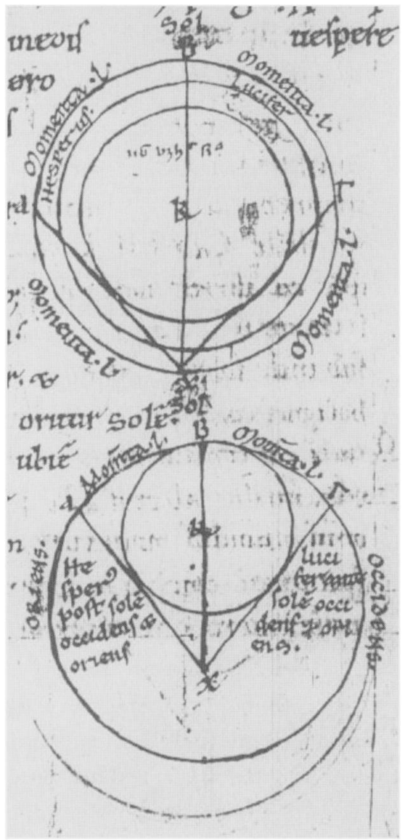

Figure IV.8. Bounded elongation of Venus—descriptive. Standard, corrupt form (upper) and corrected version (lower). Leiden Universiteitsbibliotheek, Ms. BPL 64, f.85v. Reproduced with permission of the Department of Western Manuscripts, University of Leiden.

zodiacal arc AΔ and to have hastened further towards the preceding signs. Again, after having moved through HZ, it seems to us to have finally retreated through ΔA to B in opposition to the following signs and therefore to be in retrograde. And when it recedes a small distance from Z, where it appears at B, it seems to stay in the same position. And then as it recesses farther and passes its outer limit E and reaches H, again it is judged to be at Δ and to have traveled toward the preceding signs, and while receding from H along HZ to have retreated to B.[8]

[8]Our translation.

5 BOUNDED ELONGATION OF VENUS—DESCRIPTIVE DIAGRAM

5.1 DESCRIPTION

The manuscript diagrams for this text and for that following it, the epicyclic explanation of Venus's elongation, are among the most corrupted in all of the Calcidian corpus. The positions of X and K vary extensively, and there are usually two concentric circles within the zodiacal circle, neither of which is called for by the text. However, most scribes either chose not to correct these variants in their exemplars or else did not recognize any error in such variant diagrams. From the eleventh century onward, some scholars did recognize and correct them.

The text calls for a severely descriptive, not explanatory, image (Fig. IV.8). The zodiacal circle, a central Earth at X, a radius passing through the Sun's center K to the point B, and two radii to two zodiacal points A and Γ, located respectively 50° to the east and to the west of B, are sufficient to complete the diagram. With the Sun always seen along XKB, the planet Venus never appears farther away from it than the two limiting radii XA and XΓ at angles of 50° from XKB.

5.2 TEXT AND TRANSLATION

CXI. Sit igitur punctum terrae caelique ubi est littera X, zodiacus vero circulus, super quem sunt ABΓ notae, et sit AB ambitus momentorum quinquaginta, item BΓ ambitus totidem momentorum, et per XB lineam punctum sit solis in littera K. Erit ergo linea XKB quae solem demonstrat, id est litteram B; tantum autem moveatur haec eadem linea quantum sol movetur prope cotidiana momenta singula, similiter ceterae lineae XA et XΓ dividantur in quinquaginta momenta. Sit porro XA linea in parte orientis, XΓ vero linea in parte occidentis, haec quidem, id est XΓ linea, prius occidens et prius oriens quam sol, illa vero alia XA posterius occidens et posterius exoriens. Necesse est igitur ut haec quidem, id est XA linea, demonstret Luciferum in littera A Hesperum eo videlicet tempore, quo eadem stella longius a sole discesserit, illa vero alia linea, id est XΓ, eandem stellam demonstret esse Luciferum temporibus matutinis in signo litterae Γ.[9]

CXI. Therefore let the center of the Earth and of the heavens be at X; let there be the zodiacal circle, on which are ABΓ, and let AB and BΓ each be an arc of 50° and along the line XB let the center of the Sun be at K. Thus line XKB will locate the Sun at B [on the zodiacal circle], and let this same line be moved the same amount as the Sun, about 1° per day, and likewise let those lines XA and XΓ be separated [constantly from XB] by 50°. Next let XA be the line to the east and XΓ be the line to the west, the latter setting and rising before the Sun, the former

[9] Calcidius (1962), pp. 157-8.

setting and rising after the Sun. Thus the line XA must locate Lucifer (Venus) at A as Hesper when this planet has withdrawn to its maximum from the Sun, while the line XΓ locates the same planet as Lucifer at Γ early in the morning.[10]

6 Bounded Elongation of Venus—Epicyclic Diagram

6.1 Description

The manuscript diagrams for this text are often confusing, and it is less easy to categorize them than the diagrams for the previous text, which gives the observational account of Venus's elongation. As the text says, the epicyclic explanation builds on the immediately preceding text that describes the visible elongation. However, with the positions of X and K already misplaced in most of the diagrams for the prior text, any attempt to add an epicyclic circle for Venus would usually result in further error. Nonetheless, certain scholars of the eleventh century did reconstruct the diagrams correctly from the text (Fig. IV.9). The epicyclical account of Venus's elongation prescribes a circle cutting the zodiacal radius XKB. This radius passes from the Earth through the Sun at K, but the distance from X to K is nowhere stated. While it would seem proper to make this radius bisect the epicyclic circle, the location of K is possible at the center of the epicycle, below this center, or completely outside and below the epicycle. The last option would fit Plato's planetary order, which has Venus farther than the Sun from the Earth. In any case, Calcidius does not specify the location of K with respect to the epicycle. The main purpose of the epicycle is not to show the order of planets but to show the limited movement of Venus with respect to the Sun, and the account does this. The epicycle ΔEZH is drawn into the preexisting diagram for the simple phenomenal description so that the epicycle fits between the zodiacal circle ABΓ and its center X and is tangent to the two preset radii XA and XΓ, which pass to points 50° to either side of the zodiacal point B.

6.2 Text and Translation

Hoc autem fiet apertius, si per XKB lineam circumducatur circulus qui contingat duas a se distantes lineas, id est XA et XΓ, quae demonstrant modum discessionis a sole Luciferi.

CXII. At vero Plato quique huius indaginis diligentius examen habuerunt affirmant aliquanto quam solis esse elatiorem Luciferi globum qui limitatur notis ΔEZH contingens KA quidem lineam per E litteram, KΓ vero per H. Quare, cum Lucifer lustrans circulum proprium perveniet ad E, videbitur in A locatus a sole plurimum, utpote momentis quinquaginta omnibus, separatus et ad orientem

[10]Our translation.

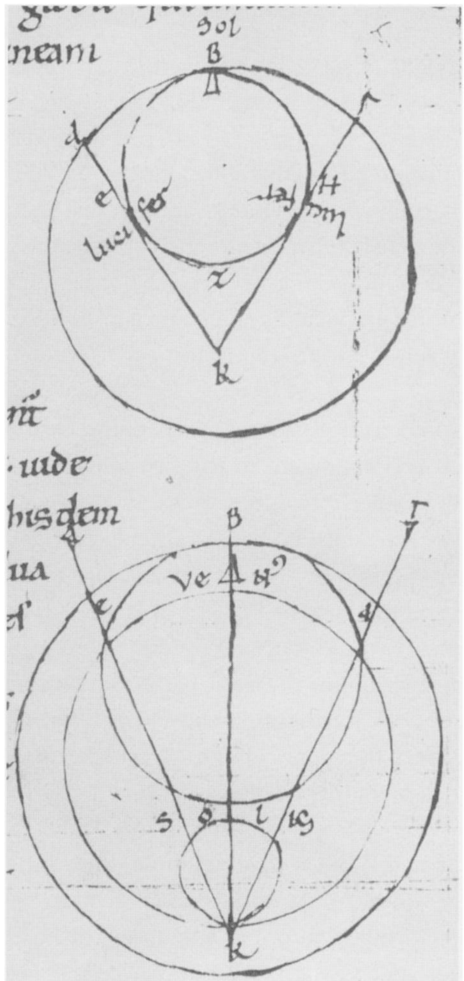

Figure IV.9. Bounded elongation of Venus—epicyclic. Partially corrected form (upper) and standard, corrupt version (lower). Leiden Universiteitsbibliotheek, Ms. BPL 64, f.86r. Reproduced with permission of the Department of Western Manuscripts, University of Leiden.

ac diem vergens; quippe sol non nisi ubi est B littera indifferenter uidetur. Porro cum in H erit Lucifer, videbitur in excelsitate Γ consistere isdem quinquaginta demum momentis a sole et ad occidua semotior, cum vero vel penes Δ vel penes Z consistet, dubium non est proximum soli factum visum iri concursumque fecisse

unum excelsiorem procul a regione terrae penes Δ, alterum citimum terraeque proximum in Z. Iam illud observatione diligentiore perceptum stellam ipsam in maxima secessione, sive orientalis seu occidua erit illa secessio diebus fere quingentis octoginta et quattuor ad id in quo pridem fuerat vel E vel H remeare, ut sit perspicuum totum obire circulum suum, qui est ΔEZH, memoratam stellam memorato numero dierum, ita ut maiorem quidem discessionis ambitum, qui est ab eois ad occidua, hoc est HΔE, quadringentis quadraginta octo peragret diebus, minorem vero depressioremque, id est EZH, reliquis centum triginta et sex, maximae siquidem discessionis ab occiduis ad eoa prolapsio hoc dierum numero revocatur, ut frequens veterum virorum observatio palam fecit.[11]

[The bounded elongation of Venus] will become clearer, if a circle is drawn through the line XKB and is tangent to the two lines XA and XG, which locate the extent of Venus's elongation from the Sun.

c. CXII. Indeed Plato and all who have examined this matter quite diligently affirm how much higher that that of the Sun is the *globus* of Venus, which is bounded by the letters ΔEZH and touches the line XA at E and XΓ at H. Wherefore, when Venus travelling its own circle comes to E, it will seem to be at A, farthest away from the Sun, by the full 50°, in the east just at daybreak, inasmuch as the Sun appears definitely to be at B. Further on, when Venus is at H, it will seem to be far out at Γ, very remote from the Sun, and to the west by exactly the same 50°. When Venus is under either Δ or Z, there is no doubt that it appears nearest the Sun and passes at one time a great distance from the Earth under Δ, another time closer and nearest to the Earth at Z. Now through quite diligent observation it has been noted that, under maximum elongation, whether at rising or at setting, this planet will take 584 days to return to that point, whether E or H, at which it was before. Given that the same planet in the same number of days covers its whole circle ΔEZH, the major segment of its course, HΔE, from rising to setting, is covered in 448 days. The minor and lower segment, EZH, takes the remaining 136 days, since passage through the maximum interval from setting to rising is accomplished in this number of days, as a common observation of the ancients made known.[12]

7 VENUS IN RETROGRADE MOTION DIAGRAM

7.1 DESCRIPTION

When in retrograde motion, a planet appears to move from east to west, rather than the normal direction of planets from west to east. The manuscript diagrams

[11] Calcidius (1962), pp. 158-9.
[12] Our translation.

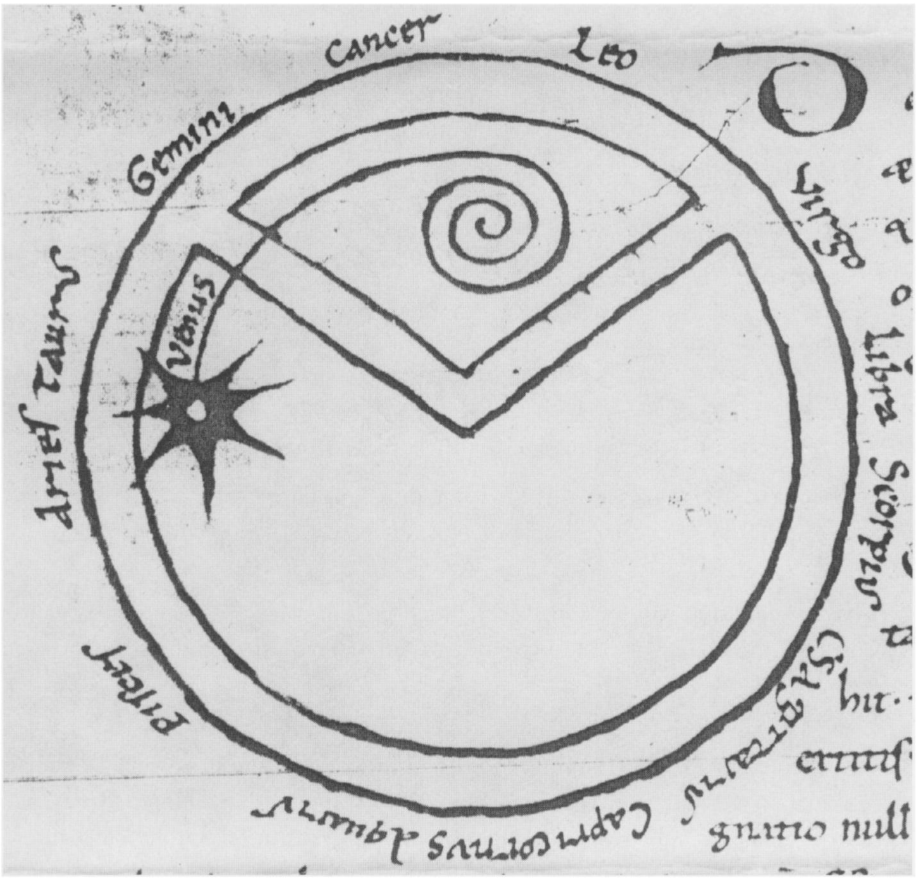

Figure IV.10. Venus in retrograde—zodiacal. Leiden Universiteitsbibliotheek, Ms. BPL 64, f.87v. Reproduced with permission of the Department of Western Manuscripts, University of Leiden.

for this text present two traditions, (1) the single spiral for Venus within a zodiacal band (Fig. IV.10) and (2) three connected and different spirals with no labels and no zodiacal framework (Fig. IV.11). The former is by far the more common, but both begin as early as the ninth century. In this paragraph Calcidius simply expands on the brief description of Plato. Plato's label of the spiral as like the acanthus coil is described more elaborately but with no greater precision. Calcidius makes clear that the careful control of a circular drawing instrument will produce the desired curve. He then goes on to say that in the heavens the resulting appearance for us

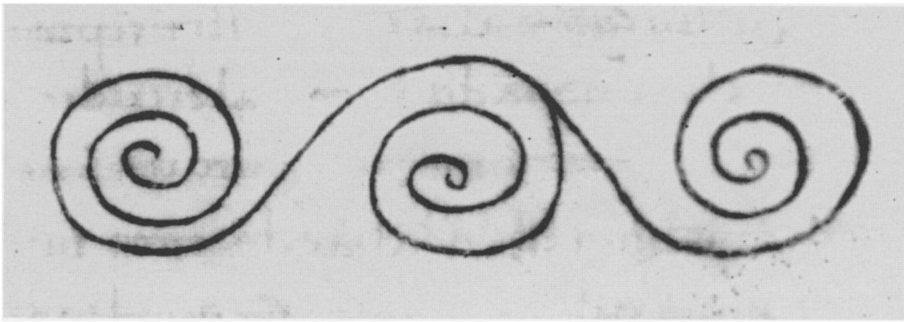

Figure IV.11. Venus in retrograde—three coils. Bibliothèque municipale de Lyon, Ms 374, f. 31v. Crédit photographique Bibliothèque municipale de Lyon, Didier Nicole.

will be irregular and will tend in either direction from the intial observed location of Venus in the zodiac, depending on the speed of revolution in the spiral.

7.2 Text and Translation

CXVI. Deinde prosequitur: Omnes quippe circulos eorum uniformis et inerrabilis illa conversio vertens in spiram et velut sinuosum acanthi volumen. Cum fixo cardine circini casu vel etiam voluntate nostra oppresso aut relaxato circino describuntur circuli tales, ut postremitas circumductae lineae non solum non perveniat ad exordium, sed deflectens a competenti rigore infra vel supra circumducta linea saepius artiores laxioresue circulos faciat, hoc genus circulorum spiram solemus vocare vel acanthi volumen. Igitur quia planetas sic aplanes rapit cotidiana vertigine, ut non patiatur eos in eundem locum et velut sedem ex qua progressi fuerant repraesentari, sed vel transire cogat vel leniore progressione minime occurrere ad destinata, recte dixit errantes stellas in spiram et velut sinuosum acanthi volumen rotari ob inconstantem atque inaequabilem circumvectionem. Ut si stella forte Veneris sit in Arietis signo, deinde rapiat eam mundi conversio, ita ut eam longius a pridiana progressione protrahat, certe tunc aliqua fiet ab Ariete discessio; quantoque plures conversiones fient, tanto longius ab Ariete ad praecedentia signa discedet et ad postremum ad Pisces atque inde ad Aquarium provehetur. Contra si remissior erit raptatio, ab Ariete ad Taurum versus recedet et ad Geminos atque Cancrum iniquis semper gyris et deflectentibus ab exordiis atque aberrantibus a convenienti rigore; quos quidem gyros Graeci helicas appellant; quorum incrementa ab imminutionibus, imminutiones porro ab incrementis notantur suntque

similes eius formulae quae subter ascripta est.[13]

CXVI. Then he [Plato, in *Timaeus* 39A,] continues, "That uniform and inerrant revolving turns all the circles of those [planets] into a spiral, rather like the winding coil of an acanthus." With center fixed, by the decreasing of a [geometer's] compass, or, as we may wish, by a tighter or more relaxed compass, the circles will be described such that the end point of the circularly drawn line not only does not reach its beginning point but, diverging by a suitable invariance within or outside the regular circular line, makes tighter and tighter or looser and looser circles. This kind of circle we usually call a spiral or the scroll of acanthus. Therefore, because the celestial sphere drives the planets with a daily rotation [from east to west], so that it does not allow them to reappear in the same place, or seat, from which they advanced, but forces them either to transit or by a smaller progress not to reach the destination, he [Plato] correctly said that the planets turn in a spiral like the serpentine scroll of the acanthus because of an inconstant and unequal revolution. So if a planet like Venus is in the sign of Aries, then the rotation of the outer sphere drives it, so that it extends farther forward from the daily rotation, so there arises some separation from Aries. However many more rotations occur, that much farther from Aries toward the preceding sign it moves, toward Pisces and then to Aquarius. On the other hand, if the speed is more diminished, it moves away toward Taurus and to Gemini and Cancer by always unequal spinnings and deflections from its origins and divergences from an agreed invariance. These spinnings the Greeks call *helices*, the increments of which by diminutions and likewise the diminutions by increments are prescribed, and they are as in that formula that is written [in a paragraph] below.[14]

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[13] Calcidius (1962), pp. 160-161.

[14] Our translation.

8 CATALOGUE OF MANUSCRIPTS

Label	Library Reference	Century
Calc1	Arezzo B d. città, 431, f.23v	XV
Calc2	Arezzo B d. città, 431, f.24v	XV
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Calc4	Arezzo B d. città, 431, f.27r	XV
Calc5	Arezzo B d. città, 431, f.34v	XV
Calc6	Arezzo B d. città, 431, f.35r	XV
Calc7	Arezzo B d città, 431, f. 36r	XV
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Calc59	Köln DB, 192, f.49r	XI
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Calc61	Köln DB, 192, f.51v	XI
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Calc163	Paris BNF, lat. 10195, f.106r	XI
Calc164	Paris BNF, lat. 10195, f.98v	XI
Calc165	Paris BNF, lat. 10195, f.99r	XI
Calc166	Paris BNF, lat. 10195, f.99v	XI
Calc167	Paris BNF, lat. 2164, f. 42v	XII(in)
Calc168	Paris BNF, lat. 2164, f.37r	X(3/4)
Calc169	Paris BNF, lat. 2164, f.37v	X(3/4)
Calc170	Paris BNF, lat. 2164, f.38r	X(3/4)
Calc171	Paris BNF, lat. 2164, f.38v	X(3/4)
Calc172	Paris BNF, lat. 2164, f.42r	X(3/4)
Calc173	Paris BNF, lat. 6280, f. 28v	XI
Calc174	Paris BNF, lat. 6280, f.21v	XI
Calc175	Paris BNF, lat. 6280, f.22r	XI
Calc176	Paris BNF, lat. 6280, f.22v	XI
Calc177	Paris BNF, lat. 6280, f.23v	XI
Calc178	Paris BNF, lat. 6280, f.28r	XI
Calc179	Paris BNF, lat. 6281, f.48v	XII(in)
Calc180	Paris BNF, lat. 6281, f.40v	XII(in)
Calc181	Paris BNF, lat. 6281, f.41r	XII(in)
Calc182	Paris BNF, lat. 6281, f.42r	XII(in)
Calc183	Paris BNF, lat. 6281, f.47r	XII(in)
Calc184	Paris BNF, lat. 6281, f.47v	XII(in)
Calc185	Paris BNF, lat. 6282, f.42r	XI(m)
Calc186	Paris BNF, lat. 6282, f.42r	XI(m)
Calc187	Paris BNF, lat. 6282, f.31r	XI(m)
Calc188	Paris BNF, lat. 6282, f.32r	XI(m)

Label	Library Reference	Century
Calc189	Paris BNF, lat. 6282, f.33r	XI(m)
Calc190	Paris BNF, lat. 6282, f.34r	XI(m)
Calc191	Paris BNF, lat. 6282, f.40v	XI(m)
Calc192	Paris BNF, lat. 6282, f.41r	XI(m)
Calc193	Paris BNF, lat. 6570, f.21v	XII(2/2)
Calc194	Paris BNF, lat. 6570, f.15r	XII(2/2)
Calc195	Paris BNF, lat. 6570, f.16r	XII(2/2)
Calc196	Paris BNF, lat. 6570, f.16v	XII(2/2)
Calc197	Paris BNF, lat. 6570, f.17r	XII(2/2)
Calc198	Paris BNF, lat. 6570, f.21r	XII(2/2)
Calc199	Paris BNF, lat. 6570, f.21v	XII(2/2)
Calc200	Paris BNF, lat. 7188, f. 90r	XII(in)
Calc201	Paris BNF, lat. 7188, f.84r	XII(in)
Calc202	Paris BNF, lat. 7188, f.84v	XII(in)
Calc203	Paris BNF, lat. 7188, f.85r	XII(in)
Calc204	Paris BNF, lat. 7188, f.86r	XII(in)
Calc205	Paris BNF, lat. 7188, f.89r	XII(in)
Calc206	Paris BNF, lat. 7188, f.89v	XII(in)
Calc207	Praha SK, III.A.13, f.105v	XIV
Calc208	Praha SK, III.A.13, f.106r	XIV
Calc209	Praha SK, III.A.13, f.106v	XIV
Calc210	Praha SK, III.A.13, f.107r	XIV
Calc211	Praha SK, III.A.13, f.99r	XIV
Calc212	Praha SK, III.A.13, f.99v	XIV
Calc213	Trier Bist, 28, f.15v	XII(ex)
Calc214	Trier Bist, 28, f.16r	XII(ex)
Calc215	Trier Bist, 28, f.16v	XII(ex)
Calc216	Trier Bist, 28, f.17v	XII(ex)
Calc217	Trier Bist, 28, f.21v	XII(ex)
Calc218	Trier Bist, 28, f.22r	XII(ex)
Calc219	Valenciennes BM, 293, f. 62r	IX(4/4)
Calc220	Valenciennes BM, 293, f.47r	IX(4/4)
Calc221	Valenciennes BM, 293, f.48v	IX(4/4)
Calc222	Valenciennes BM, 293, f.49v	IX(4/4)
Calc223	Valenciennes BM, 293, f.51r	IX(4/4)
Calc224	Valenciennes BM, 293, f.60r	IX(4/4)
Calc225	Valenciennes BM, 293, f.60v	IX(4/4)
Calc226	Vaticano BAV, Barb. lat. 21, f. 61r	XI

Label	Library Reference	Century
Calc227	Vaticano BAV, Barb. lat. 21, f.51v	XI
Calc228	Vaticano BAV, Barb. lat. 21, f.52r	XI
Calc229	Vaticano BAV, Barb. lat. 21, f.53r	XI
Calc230	Vaticano BAV, Barb. lat. 21, f.54r	XI
Calc231	Vaticano BAV, Barb. lat. 21, f.59v	XI
Calc232	Vaticano BAV, Barb. lat. 21, f.60r	XI
Calc233	Vaticano BAV, Barb. lat. 22, f.32r	XI(ex)
Calc234	Vaticano BAV, Barb. lat. 22, f.23v	XI(ex)
Calc235	Vaticano BAV, Barb. lat. 22, f.24r	XI(ex)
Calc236	Vaticano BAV, Barb. lat. 22, f.24v	XI(ex)
Calc237	Vaticano BAV, Barb. lat. 22, f.25v	XI(ex)
Calc238	Vaticano BAV, Barb. lat. 22, f.31r	XI(ex)
Calc239	Vaticano BAV, Chigi lat. E.VI.194, f.50v	XV
Calc240	Vaticano BAV, Chigi lat. E.VI.194, f.38r	XV
Calc241	Vaticano BAV, Chigi lat. E.VI.194, f.39r	XV
Calc242	Vaticano BAV, Chigi lat. E.VI.194, f.40r	XV
Calc243	Vaticano BAV, Chigi lat. E.VI.194, f.41v	XV
Calc244	Vaticano BAV, Chigi lat. E.VI.194, f.49v	XV
Calc245	Vaticano BAV, Chigi lat. E.VI.194, f.50r	XV
Calc246	Vaticano BAV, Regin. lat. 1114, f.46r	XIII
Calc247	Vaticano BAV, Regin. lat. 1114, f.39r	XIII
Calc248	Vaticano BAV, Regin. lat. 1114, f.40r	XIII
Calc249	Vaticano BAV, Regin. lat. 1114, f.40v	XIII
Calc250	Vaticano BAV, Regin. lat. 1114, f.41r	XIII
Calc251	Vaticano BAV, Regin. lat. 1114, f.45v	XIII
Calc252	Vaticano BAV, Regin. lat. 1114, f.46r	XIII
Calc253	Vaticano BAV, Regin. lat. 123, f.209r	XI(1056)
Calc254	Vaticano BAV, Regin. lat. 123, f.210r	XI(1056)
Calc255	Vaticano BAV, Regin. lat. 123, f.210v	XI(1056)
Calc256	Vaticano BAV, Regin. lat. 123, f.211v	XI(1056)
Calc257	Vaticano BAV, Regin. lat. 123, f.216v	XI(1056)
Calc258	Vaticano BAV, Regin. lat. 123, f.217r	XI(1056)
Calc259	Vaticano BAV, Regin. lat. 1308, f.20v	X(1/2)
Calc260	Vaticano BAV, Regin. lat. 1308, f.26r	X(1/2)
Calc261	Vaticano BAV, Regin. lat. 1308, f.19r	X(1/2)
Calc262	Vaticano BAV, Regin. lat. 1308, f.20r	X(1/2)
Calc263	Vaticano BAV, Regin. lat. 1308, f.21 r	X(1/2)
Calc264	Vaticano BAV, Regin. lat. 1308, f.25r	X(1/2)

Label	Library Reference	Century
Calc265	Vaticano BAV, Regin. lat. 1308, f.25v	X(1/2)
Calc266	Vaticano BAV, Regin. lat. 1861, f. 47v	XI
Calc267	Vaticano BAV, Regin. lat. 1861, f.36bis	XI
Calc268	Vaticano BAV, Regin. lat. 1861, f.36r	XI
Calc269	Vaticano BAV, Regin. lat. 1861, f.37r	XI
Calc270	Vaticano BAV, Regin. lat. 1861, f.38r	XI
Calc271	Vaticano BAV, Regin. lat. 1861, f.39r	XI
Calc272	Vaticano BAV, Regin. lat. 1861, f.46v	XI
Calc273	Vaticano BAV, Regin. lat. 1861, f.47r	XI
Calc274	Vaticano BAV, Regin. lat. 1861, f.48r	XI
Calc275	Vaticano BAV, Urb. lat. 203, f. 61r	XV
Calc276	Vaticano BAV, Urb. lat. 203, f.44r	XV
Calc277	Vaticano BAV, Urb. lat. 203, f.46r	XV
Calc278	Vaticano BAV, Urb. lat. 203, f.46v	XV
Calc279	Vaticano BAV, Urb. lat. 203, f.48v	XV
Calc280	Vaticano BAV, Urb. lat. 203, f.58v	XV
Calc281	Vaticano BAV, Urb. lat. 203, f.59v	XV
Calc282	Vaticano BAV, Vat. lat. 1544, f. 79r	XV(1470)
Calc283	Vaticano BAV, Vat. lat. 1544, f.31r	XV(1470)
Calc284	Vaticano BAV, Vat. lat. 1544, f.69v	XV(1470)
Calc285	Vaticano BAV, Vat. lat. 1544, f.70v	XV(1470)
Calc286	Vaticano BAV, Vat. lat. 1544, f.72r	XV(1470)
Calc287	Vaticano BAV, Vat. lat. 1544, f.77v	XV(1470)
Calc288	Vaticano BAV, Vat. lat. 1544, f.78r	XV(1470)
Calc289	Wien NB, cod. 176, f.38v	XII
Calc290	Wien NB, cod. 176, f.39v	XII
Calc291	Wien NB, cod. 176, f.40v	XII
Calc292	Wien NB, cod. 176, f.42r	XII
Calc293	Wien NB, cod. 176, f.49v	XII
Calc294	Wien NB, cod. 176, f.50r	XII
Calc295	Wien NB, cod. 443, f. 184v	XI(1/2)
Calc296	Wien NB, cod. 443, f.173v	XI(1/2)
Calc297	Wien NB, cod. 443, f.174v	XI(1/2)
Calc298	Wien NB, cod. 443, f.175v	XI(1/2)
Calc299	Wien NB, cod. 443, f.176v	XI(1/2)
Calc300	Wien NB, cod. 443, f.183r	XI(1/2)
Calc301	Wien NB, cod. 443, f.183v	XI(1/2)
Calc302	Wolfenbüttel HAB, Ms 116 Gud. lat. 2°, f.30v	XI

Label	Library Reference	Century
Calc303	Wolfenbüttel HAB, Ms 116 Gud. lat. 2°, f.31r	XI
Calc304	Wolfenbüttel HAB, Ms 116 Gud. lat. 2°, f.32r	XI
Calc305	Wolfenbüttel HAB, Ms 116 Gud. lat. 2°, f.33r	XI
Calc306	Wolfenbüttel HAB, Ms 116 Gud. lat. 2°, f.39v	XI
Calc307	Wolfenbüttel HAB, Ms 116 Gud. lat. 2°, f.40r	XI
Calc308	Oxford BoL, Canon. Class. lat. 175, f.25r	XV(1459)
Calc309	Paris BNF, lat. 6570, f.17r	XII(2/2)
Calc310	Vaticano BAV, Regin. lat. 1114, f.40v	XIII
Calc311	Leiden UB, BPL 64, f.77v	XI
Calc312	Cambridge Sidney Sussex CL, Δ.2.9, f.126r	XIV
Calc313	Firenze BML, Plut. 84.24, f.34v	XV
Calc314	Firenze BN, Conv. Soppr. J.IX.40, f.43r	XII
Calc315	Krakow BUJ, 665, f.27v	XV
Calc316	London BL, Roy. 12.B.XXII, f.33v	XII(in)
Calc317	Milano BA, S.14 sup., f.28v	XV(1454)
Calc318	München SB, clm13021, f.240r	XII(2/2)
Calc319	Oxford BoL, Canon. Class. lat. 176, f.57v	XV
Calc320	Paris BNF, lat. 2164, f.42r	X(3/4)
Calc321	Paris BNF, lat. 6280, f.28r	XI
Calc322	Praha SK, III.A.13, f.99r	XIV
Calc323	Vaticano BAV, Barb. lat. 22, f.31r	XI(ex)
Calc324	Vaticano BAV, Chigi lat. E.VI.194, f.49v	XV

9 CATALOGUE OF DIAGRAMS

Label	Diagram Topic	Location in Text
Calc5	Bounded elongation of Venus—descriptive	c.111
Calc13	Bounded elongation of Venus—descriptive	c.111
Calc20	Bounded elongation of Venus—descriptive	c.112
Calc26	Bounded elongation of Venus—descriptive	c.111
Calc42	Bounded elongation of Venus—descriptive	c.112
Calc49	Bounded elongation of Venus—descriptive	cc.111-112
Calc59	Bounded elongation of Venus—descriptive	c.111
Calc66	Bounded elongation of Venus—descriptive	c.111
Calc79	Bounded elongation of Venus—descriptive	cc.110-111
Calc84	Bounded elongation of Venus—descriptive	c.111
Calc90	Bounded elongation of Venus—descriptive	c.111
Calc96	Bounded elongation of Venus—descriptive	c.112
Calc109	Bounded elongation of Venus—descriptive	c.111
Calc120	Bounded elongation of Venus—descriptive	cc.112-113
Calc128	Bounded elongation of Venus—descriptive	c.112
Calc141	Bounded elongation of Venus—descriptive	c.112
Calc144	Bounded elongation of Venus—descriptive	c.112
Calc148	Bounded elongation of Venus—descriptive	c.112
Calc149	Bounded elongation of Venus—descriptive	c.113
Calc155	Bounded elongation of Venus—descriptive	c.111
Calc162	Bounded elongation of Venus—descriptive	c.111
Calc163	Bounded elongation of Venus—descriptive	c.112
Calc183	Bounded elongation of Venus—descriptive	c.111
Calc191	Bounded elongation of Venus—descriptive	c.112
Calc199	Bounded elongation of Venus—descriptive	cc.111-113
Calc205	Bounded elongation of Venus—descriptive	c.111
Calc217	Bounded elongation of Venus—descriptive	c.112
Calc224	Bounded elongation of Venus—descriptive	c.111
Calc231	Bounded elongation of Venus—descriptive	c.111
Calc251	Bounded elongation of Venus—descriptive	c.111
Calc257	Bounded elongation of Venus—descriptive	c.111
Calc264	Bounded elongation of Venus—descriptive	c.111
Calc272	Bounded elongation of Venus—descriptive	c.112
Calc280	Bounded elongation of Venus—descriptive	c.111
Calc287	Bounded elongation of Venus—descriptive	c.111
Calc293	Bounded elongation of Venus—descriptive	c.112

Label	Diagram Topic	Location in Text
Calc300	Bounded elongation of Venus—descriptive	cc.111-112
Calc306	Bounded elongation of Venus—descriptive	c.111
Calc28	Bounded elongation of Venus—descriptive; —epicyclic	c.112
Calc35	Bounded elongation of Venus—descriptive; —epicyclic	cc.112-113
Calc55	Bounded elongation of Venus—descriptive; —epicyclic	cc.112-113
Calc73	Bounded elongation of Venus—descriptive; —epicyclic	cc.111-112
Calc103	Bounded elongation of Venus—descriptive; —epicyclic	cc.111-113
Calc115	Bounded elongation of Venus—descriptive; —epicyclic	c.89
Calc134	Bounded elongation of Venus—descriptive; —epicyclic	cc.111-112
Calc157	Bounded elongation of Venus—descriptive; —epicyclic	cc.112-113
Calc172	Bounded elongation of Venus—descriptive; —epicyclic	cc.111-112
Calc178	Bounded elongation of Venus—descriptive; —epicyclic	cc.112-114
Calc211	Bounded elongation of Venus—descriptive; —epicyclic	cc.111-112
Calc238	Bounded elongation of Venus—descriptive; —epicyclic	cc.111-112
Calc244	Bounded elongation of Venus—descriptive; —epicyclic	cc.112-113
Calc6	Bounded elongation of Venus—epicyclic	c.112
Calc14	Bounded elongation of Venus—epicyclic	c.112
Calc21	Bounded elongation of Venus—epicyclic	c.113
Calc27	Bounded elongation of Venus—epicyclic	c.112
Calc43	Bounded elongation of Venus—epicyclic	c.113
Calc50	Bounded elongation of Venus—epicyclic	cc.112-113
Calc60	Bounded elongation of Venus—epicyclic	c.112
Calc61	Bounded elongation of Venus—epicyclic	c.116
Calc67	Bounded elongation of Venus—epicyclic	c.112
Calc80	Bounded elongation of Venus—epicyclic	c.112

Label	Diagram Topic	Location in Text
Calc85	Bounded elongation of Venus—epicyclic	c.112
Calc91	Bounded elongation of Venus—epicyclic	c.112
Calc97	Bounded elongation of Venus—epicyclic	c.113
Calc110	Bounded elongation of Venus—epicyclic	c.112
Calc111	Bounded elongation of Venus—epicyclic	c.78
Calc129	Bounded elongation of Venus—epicyclic	c.113
Calc136	Bounded elongation of Venus—epicyclic	c.78
Calc143	Bounded elongation of Venus—epicyclic	c.111
Calc156	Bounded elongation of Venus—epicyclic	c.112
Calc184	Bounded elongation of Venus—epicyclic	c.112
Calc192	Bounded elongation of Venus—epicyclic	c.113
Calc194	Bounded elongation of Venus—epicyclic	cc.78-79
Calc206	Bounded elongation of Venus—epicyclic	c.112
Calc218	Bounded elongation of Venus—epicyclic	c.113
Calc225	Bounded elongation of Venus—epicyclic	c.112
Calc232	Bounded elongation of Venus—epicyclic	c.112
Calc245	Bounded elongation of Venus—epicyclic	cc.114-115
Calc252	Bounded elongation of Venus—epicyclic	c.112
Calc258	Bounded elongation of Venus—epicyclic	c.112
Calc265	Bounded elongation of Venus—epicyclic	c.112
Calc273	Bounded elongation of Venus—epicyclic	c.113
Calc274	Bounded elongation of Venus—epicyclic	c.117
Calc281	Bounded elongation of Venus—epicyclic	c.112
Calc288	Bounded elongation of Venus—epicyclic	c.112
Calc294	Bounded elongation of Venus—epicyclic	c.113
Calc301	Bounded elongation of Venus—epicyclic	c.113
Calc307	Bounded elongation of Venus—epicyclic	c.112
Calc312	Bounded elongation of Venus—epicyclic	c.112
Calc313	Bounded elongation of Venus—epicyclic	cc.112-113
Calc314	Bounded elongation of Venus—epicyclic	cc.112-113
Calc315	Bounded elongation of Venus—epicyclic	cc.111-112
Calc316	Bounded elongation of Venus—epicyclic	cc.111-113
Calc317	Bounded elongation of Venus—epicyclic	c.89
Calc318	Bounded elongation of Venus—epicyclic	cc.111-112
Calc319	Bounded elongation of Venus—epicyclic	cc.112-113
Calc320	Bounded elongation of Venus—epicyclic	cc.111-112
Calc321	Bounded elongation of Venus—epicyclic	cc.112-114
Calc322	Bounded elongation of Venus—epicyclic	cc.111-112

Label	Diagram Topic	Location in Text
Calc323	Bounded elongation of Venus—epicyclic	cc.111-112
Calc324	Bounded elongation of Venus—epicyclic	cc.112-113
Calc4	Generic epicycle	c.87
Calc12	Generic epicycle	c.86
Calc19	Generic epicycle	c.86
Calc25	Generic epicycle	c.86
Calc34	Generic epicycle	c.87
Calc41	Generic epicycle	cc.85-87
Calc48	Generic epicycle	c.86
Calc54	Generic epicycle	c.86
Calc58	Generic epicycle	c.86
Calc72	Generic epicycle	c.86
Calc78	Generic epicycle	c.87
Calc83	Generic epicycle	c.86
Calc89	Generic epicycle	cc.86-87
Calc95	Generic epicycle	c.87
Calc102	Generic epicycle	c.85
Calc108	Generic epicycle	c.86
Calc119	Generic epicycle	c.112
Calc127	Generic epicycle	c.87
Calc133	Generic epicycle	c.86
Calc140	Generic epicycle	c.111
Calc154	Generic epicycle	c.85
Calc171	Generic epicycle	c.86
Calc161	Generic epicycle	c.86
Calc182	Generic epicycle	c.87
Calc190	Generic epicycle	c.86
Calc198	Generic epicycle	cc.110-111
Calc203	Generic epicycle	c.82
Calc204	Generic epicycle	c.86
Calc210	Generic epicycle	c.80
Calc216	Generic epicycle	c.87
Calc223	Generic epicycle	c.86
Calc230	Generic epicycle	c.87
Calc237	Generic epicycle	c.86
Calc250	Generic epicycle	c.85
Calc256	Generic epicycle	c.86
Calc263	Generic epicycle	c.86

Label	Diagram Topic	Location in Text
Calc271	Generic epicycle	c.87
Calc279	Generic epicycle	c.85
Calc286	Generic epicycle	c.85
Calc292	Generic epicycle	c.87
Calc299	Generic epicycle	c.87
Calc305	Generic epicycle	c.85
Calc311	Generic epicycle	c.82
Calc1	Lengths of seasons	c.78
Calc9	Lengths of seasons	c.78
Calc16	Lengths of seasons	cc.78-79
Calc23	Lengths of seasons	c.79
Calc31	Lengths of seasons	cc.78-79
Calc38	Lengths of seasons	cc.78-79
Calc45	Lengths of seasons	c.78
Calc51	Lengths of seasons	c.78
Calc62	Lengths of seasons	c.79
Calc64	Lengths of seasons	cc.78-79
Calc68	Lengths of seasons	c.78
Calc74	Lengths of seasons	c.78
Calc92	Lengths of seasons	c.79
Calc98	Lengths of seasons	c.78
Calc105	Lengths of seasons	c.78
Calc112	Lengths of seasons	c.80
Calc116	Lengths of seasons	c.81
Calc123	Lengths of seasons	c.79
Calc130	Lengths of seasons	cc.78-79
Calc137	Lengths of seasons	c.81
Calc145	Lengths of seasons	c.79
Calc151	Lengths of seasons	c.78
Calc159	Lengths of seasons	c.79
Calc164	Lengths of seasons	c.78
Calc168	Lengths of seasons	c.78
Calc174	Lengths of seasons	c.79
Calc187	Lengths of seasons	c.78
Calc195	Lengths of seasons	c.81
Calc201	Lengths of seasons	c.78
Calc207	Lengths of seasons	c.78
Calc213	Lengths of seasons	c.79

Label	Diagram Topic	Location in Text
Calc220	Lengths of seasons	c.78
Calc227	Lengths of seasons	c.78
Calc234	Lengths of seasons	c.78-79
Calc240	Lengths of seasons	c.79
Calc247	Lengths of seasons	c.79
Calc261	Lengths of seasons	c.78
Calc284	Lengths of seasons	c.78
Calc253	Lengths of seasons	c.78
Calc268	Lengths of seasons	c.79
Calc276	Lengths of seasons	c.78
Calc289	Lengths of seasons	c.79
Calc296	Lengths of seasons	c.79
Calc302	Lengths of seasons	c.78
Calc303	Lengths of seasons	c.80
Calc2	Solar eccentric	c.80
Calc3	Solar eccentric	c.83
Calc11	Solar eccentric	c.82
Calc10	Solar eccentric	c.80
Calc17	Solar eccentric	c.80
Calc18	Solar eccentric	c.82
Calc24	Solar eccentric	c.82
Calc32	Solar eccentric	c.81
Calc37	Solar eccentric	cc.80-81
Calc39	Solar eccentric	cc.80-81
Calc46	Solar eccentric	c.81
Calc47	Solar eccentric	c.82
Calc52	Solar eccentric	cc.80-81
Calc53	Solar eccentric	cc.82-83
Calc56	Solar eccentric	c.81
Calc65	Solar eccentric	c.80
Calc69	Solar eccentric	c.80
Calc70	Solar eccentric	c.82
Calc71	Solar eccentric	c.84
Calc75	Solar eccentric	c.81
Calc77	Solar eccentric	c.84
Calc82	Solar eccentric	c.82
Calc87	Solar eccentric	c.80
Calc93	Solar eccentric	c.81

Label	Diagram Topic	Location in Text
Calc99	Solar eccentric	c.80
Calc100	Solar eccentric	cc.80-81
Calc106	Solar eccentric	c.80
Calc107	Solar eccentric	c.82
Calc113	Solar eccentric	c.82
Calc114	Solar eccentric	cc.111-112
Calc117	Solar eccentric	c.89
Calc118	Solar eccentric	c.87
Calc124	Solar eccentric	c.81
Calc125	Solar eccentric	c.81
Calc126	Solar eccentric	c.83
Calc131	Solar eccentric	cc.80-81
Calc132	Solar eccentric	c.82
Calc138	Solar eccentric	c.82
Calc139	Solar eccentric	c.87
Calc146	Solar eccentric	c.81
Calc147	Solar eccentric	c.83
Calc152	Solar eccentric	c.80
Calc165	Solar eccentric	c.81
Calc169	Solar eccentric	c.80
Calc175	Solar eccentric	c.81
Calc180	Solar eccentric	c.81
Calc188	Solar eccentric	c.80
Calc196	Solar eccentric	cc.82-83
Calc202	Solar eccentric	c.80
Calc208	Solar eccentric	c.80
Calc209	Solar eccentric	c.78
Calc214	Solar eccentric	c.81
Calc215	Solar eccentric	c.83
Calc221	Solar eccentric	c.80
Calc222	Solar eccentric	c.82
Calc228	Solar eccentric	c.80
Calc235	Solar eccentric	c.80
Calc241	Solar eccentric	c.81
Calc248	Solar eccentric	c.81
Calc254	Solar eccentric	c.80
Calc262	Solar eccentric	c.80
Calc267	Solar eccentric	c.80

Label	Diagram Topic	Location in Text
Calc269	Solar eccentric	c.81
Calc277	Solar eccentric	c.80
Calc285	Solar eccentric	c.80
Calc290	Solar eccentric	c.81
Calc297	Solar eccentric	c.80
Calc304	Solar eccentric	c.81
Calc76	Solar eccentric	c.82
Calc153	Solar eccentric	c.81
Calc197	Solar eccentric	c.87
Calc249	Solar eccentric	c.82
Calc33	Solar epicycle	c.82
Calc40	Solar epicycle	cc.82-83
Calc57	Solar epicycle	c.83
Calc88	Solar epicycle	cc.82-83
Calc94	Solar epicycle	c.83
Calc101	Solar epicycle	c.82
Calc166	Solar epicycle	c.82
Calc170	Solar epicycle	cc.82-83
Calc176	Solar epicycle	cc.82-83
Calc177	Solar epicycle	cc.86-87
Calc181	Solar epicycle	c.83
Calc189	Solar epicycle	cc.82-83
Calc229	Solar epicycle	c.83
Calc236	Solar epicycle	c.82
Calc242	Solar epicycle	c.82
Calc243	Solar epicycle	c.87
Calc255	Solar epicycle	c.82
Calc259	Solar epicycle	c.82
Calc270	Solar epicycle	c.83
Calc278	Solar epicycle	c.81
Calc283	Solar epicycle	c.81
Calc291	Solar epicycle	c.83
Calc298	Solar epicycle	cc.82-83
Calc308	Solar epicycle	c.81
Calc309	Solar epicycle	c.87
Calc310	Solar epicycle	c.82
Calc8	Venus retrograde—three coils	c.116-17
Calc104	Venus retrograde—three coils	c.116-17

Label	Diagram Topic	Location in Text
Calc167	Venus retrograde—three coils	c.116
Calc185	Venus retrograde—three coils	c.116
Calc186	Venus retrograde—three coils	c.116
Calc266	Venus retrograde—three coils	c.116
Calc7	Venus retrograde—zodiacal	c.116-17
Calc15	Venus retrograde—zodiacal	c.117
Calc22	Venus retrograde—zodiacal	c.116
Calc29	Venus retrograde—zodiacal	c.117
Calc30	Venus retrograde—zodiacal	c.117
Calc36	Venus retrograde—zodiacal	c.117
Calc44	Venus retrograde—zodiacal	c.117
Calc63	Venus retrograde—zodiacal	c.116
Calc81	Venus retrograde—zodiacal	c.117
Calc86	Venus retrograde—zodiacal	c.116
Calc121	Venus retrograde—zodiacal	c.116-17
Calc122	Venus retrograde—zodiacal	c.117
Calc135	Venus retrograde—zodiacal	c.116
Calc142	Venus retrograde—zodiacal	c.117
Calc150	Venus retrograde—zodiacal	c.117
Calc158	Venus retrograde—zodiacal	c.117
Calc160	Venus retrograde—zodiacal	c.116
Calc173	Venus retrograde—zodiacal	c.116-17
Calc179	Venus retrograde—zodiacal	c.116
Calc193	Venus retrograde—zodiacal	c.112
Calc200	Venus retrograde—zodiacal	c.117
Calc212	Venus retrograde—zodiacal	c.116
Calc219	Venus retrograde—zodiacal	c.116-17
Calc226	Venus retrograde—zodiacal	c.116-17
Calc233	Venus retrograde—zodiacal	c.116
Calc239	Venus retrograde—zodiacal	c.116
Calc246	Venus retrograde—zodiacal	c.116
Calc260	Venus retrograde—zodiacal	c.117
Calc275	Venus retrograde—zodiacal	c.116
Calc282	Venus retrograde—zodiacal	c.116-17
Calc295	Venus retrograde—zodiacal	c.117

Chapter V

CAPELLAN DIAGRAMS

1 LIBRA-ARIES DIAGRAM

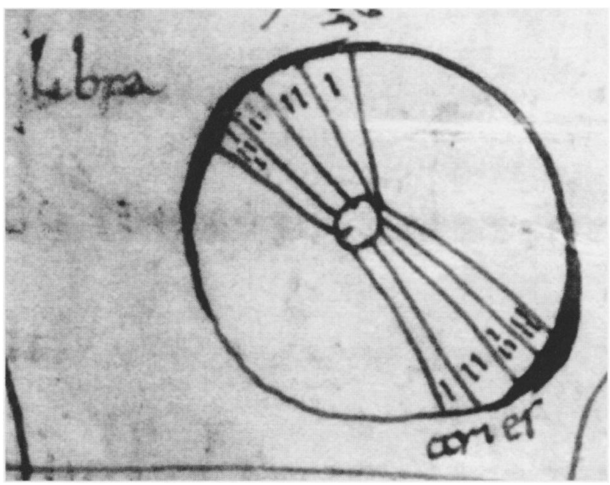

Figure V.1. Libra-Aries. Leiden Universiteitsbibliotheek, ms. Voss. lat. F.48, f. 92v. Reproduced with permission of the Department of Western Manuscripts, University of Leiden.

1.1 DESCRIPTION

We find three feasible interpretations for the Libra-Aries diagram (Fig. V.1). One interpretation emphasizes the mention by Capella (VIII.872) of successive diametrically opposed points along the ecliptic as the Sun makes its daily motion. In this passage Capella names first the opposing signs of Aries and Libra as he describes the daily passage. A second interpretation emphasizes the four numbered sections and the opposing signs as elements of Capella's description (VIII.874) of the emergence of opposite seasons on opposite sides of the globe, with the numbers referring to the four seasons and the signs Libra and Aries as the signs for equinoxes and the change of seasons. A third interpretation has elements of both the preceding ones but refers more closely to the second (VIII.874). The

signs Libra and Aries are the signs for equinoctial changes of seasons, and the four numerals refer to the first four degrees of these two signs, where, according to recognized authority (Bede, *De temporum ratione*, 6) the equinoxes occurred at the time of Creation, at 4° of Aries and at 4° of Libra. Johannes Scottus (Eriugena), *Annotationes in Marcianum*, ed. C. Lutz (Cambridge: Mediaeval Academy of America, 1939), p. 168 (at 427,6) used this definition of the equinoxes. Eriugena wrote this in the 850s.

An outer circle contains a small central circle and ten lines connecting the outer with the inner circle. These ten lines are in some cases separate lines and in other cases segments of radial lines. The ten lines appear in two groups that oppose each other. Commonly the four spaces constituted by a group of five lines contain the numerals from one to four; these numerals are always arranged as opposites. That is, proceeding counterclockwise, we find the first space in each group with the numeral for one, and so forth. Outside this arrangement of two circles with connecting lines are written the names, or abbreviations, of the two signs Libra and Aries. Each of the names appears close to one of the groups of five lines.

1.2 TEXT AND TRANSLATION

Nam sive a Cancro descendat, per eosdem usque ad brumalem circulum curret, sive a Cancro descendat, per eosdem usque ad brumalem circulum curret, sive a bruma in solstitium veniat, per ipsos denuo revolvetur; qui quidem secantes secundo zodiacum contrariis signis perpetuo lineantur. nam primus Arietis circulus primus est Librae, item secundus ac tricesimus; item Tauri prior Scorpionis est primus.[1]

For, whether the Sun is descending in its course from Cancer to the winter tropic or coming to the summer tropic from the winter solstice, it is revolving along the same circles each time. These circles cut across the zodiac twice, and are always drawn through signs that are opposite each other; the first circle of Aries is also the first of Libra, and the thirtieth of Aries is the thirtieth of Libra; similarly, the first of Taurus is the first of Scorpio, and so on.[2]

1.3 TEXT AND TRANSLATION

Verum Sol, cum ad Cancrum ab aequinoctiali parte conscendit, aestatem praestat hominibus, quos inter solstitialem septentrionalemque vivere dubium non habetur; cum ab eodem Cancro in aequinoctialem Libram descendit, auctumnum facit; cum vero ad brumalem lineam recedit, hiems habetur propterea, quod calore dimoto

[1]Capella (1983), p. 330. 13-18.

[2]Capella (1977), p. 339.

torpor invadit. rursum, cum a Capricorno hiemali in aequinoctialem Arietem surgit, vernum tempus arridet; exhinc denuo in Cancro aestas torrida renovatur. sed e contrario perferre omnia non dubitatur antipodas, quorum aestatem Capricornus facit, hiemem Cancer, Sol tenens aequinoctia utrique parti temperiem.[3]

The Sun, when it climbs upward to Cancer from the equator, brings summer to mortals who are known to be living between the summer tropic and the arctic circle; while it is descending from Cancer to the equinoctial sign of Libra, it brings autumn; and when it retires to the winter tropic, winter holds forth, because chill invades when the warmth of the Sun is remote; again as it rises from wintry Capricornus to the equinoctial sign of Aries, the season of spring smiles upon us; and as it moves from there once again, the scorching heat of summer is renewed in Cancer. Dwellers in the antipodes undoubtedly experience these seasons at opposite times; Capricornus brings their summer; Cancer winter; and the Sun at the equator brings temperate conditions to either zone.[4]

2 CONDICIONE PARTIUM DIAGRAM

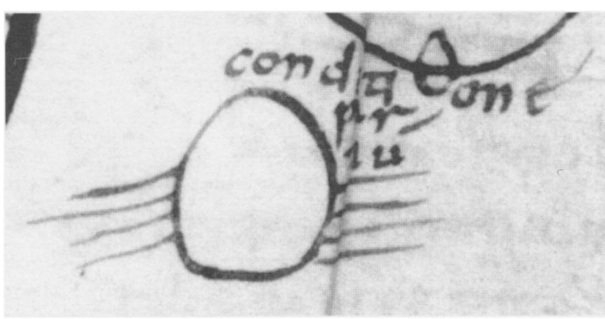

Figure V.2. Condicione partium. Leiden Universiteitsbibliotheek, Ms. Voss. lat. F.48, f. 92v. Reproduced with permission of the Department of Western Manuscripts, University of Leiden.

2.1 DESCRIPTION

In the diagram the central object is the sphere of the Sun, with the five lines on either side representing solar rays, which obscure the planet Mercury except when

[3]Capella (1983), p. 331. 9-18.
[4]Capella (1977), p. 339.

it is sufficiently elongated from the Sun to be visible while the Sun is below the horizon (Fig. V.2).

Either an oval or a circle has attached to its exterior two groups of lines more or less opposed to each other. The number of lines in each group is usually five. The lines may be horizontal, or they may be inclined to the central oval/circle. A few examples make these lines wavelike. Within each group the lines are close to parallel and do not appear as segments of lines radiating from a center. These lines never cross the central oval/circle. Outside the diagram and not involved in any part of the diagram itself is the label "condicione partium" or "condicione" or no label at all. In some cases additional clarification is made by adding a labeled circle for Mercury on either side of the Sun's rays.

2.2 Text and Translation

Quippe ubi radiis solaribus condicione partium liberatus ante emergentis splendorem iubaris vibrabundus apparet, ultra terrarum horizontem sublevatur.[5]

Indeed, when the elongation permits and the planet is not obliterated by the Sun's rays, it puts a glimmering appearance, risen above the horizon, just ahead of the brilliance of the rising Sun.[6]

3 Acutis-Spatiosis Diagram

3.1 Description

The Acutis-spatiosis diagram (Fig. V.3) represents the passage of the Moon latitudinally and obliquely through the zodiacal band.

Across five parallel and equally spaced horizontal lines a diagonal is drawn. On the middle parallel appears a small circle labeled for the Sun. Along the diagonal appears a small circle labeled for the Moon. In the acute angles formed by the intersections of diagonal and parallels are labels "acutus"; in the obtuse angles formed by the intersections of diagonal and parallels are labels "spatiosus." The phrase from the text of Capella, "aut acutis aut spatiosis," appears in complete or abbreviated form above the diagram.

3.2 Text and Translation

Denique obliquitati eius vocabulum constitutum, ut fere helicoides dicatur, ita tamen ut descendens ascendensque ipsam solarem lineam, quam mediam inter senas utriusque lateris partes esse monstravi, aut acutis aut spatiosis angulis secet, nec possit tamen ad idem, hoc est ita ut est posita, eodem mense eadem parte

[5]Capella (1983), p. 333. 19-21.

[6]Our translation.

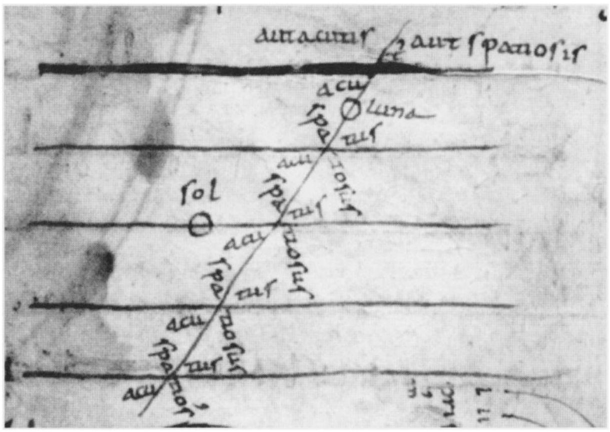

Figure V.3. Acutis-spatiosis. Leiden Universiteitsbibliotheek, Ms. Voss. lat. F.48, f. 92v. Reproduced with permission of the Department of Western Manuscripts, University of Leiden.

sic ad Solem reverti eadem latitudinis portione, nisi mense ducentesimo tricesimo quinto, hoc est anno decimo nono.[7]

A name has been given to the Moon's oblique motion; it is spoken of as *helicoides* [spiral shaped]. As it ascends or descends it cuts across the line of the ecliptic, which, as I indicated above, is a middle line with 6° on either side in sharp or opened angles. The Moon is not able to return to its former position in the same month with respect to the Sun (that is, in the same degree and in the same position in latitude) until the two hundred and thirty-fifth month, which is in the nineteenth year.[8]

4 PARTES ANGUSTANTUR DIAGRAM

4.1 DESCRIPTION

The partes angustantur diagram (Fig. V.4) represents the cosmological and geometrical fact that an object or an arc of a given metrical length will fill a smaller and smaller angle as it is removed from the center. In the text created for this diagram the emphasis is on the narrowing of angular arcs, and thus of planetary orbits, to

[7] Capella (1983), p. 328. 19-25.
[8] Capella (1977), p. 337.

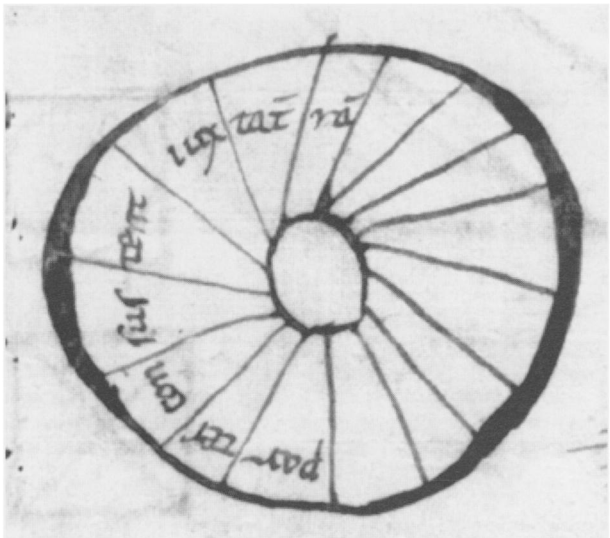

Figure V.4. Partes angustantur. Leiden Universiteitsbibliotheek, Ms. Voss. lat. F.48, f. 92v. Reproduced with permission of the Department of Western Manuscripts, University of Leiden.

shorter and shorter lengths as one approaches the central Earth. This diagram can also function as an optical diagram to show that two arcs of equal length traced by two radii of different lengths will appear under different visual angles. It is worth noting that this reasoning also appears near the end of the Plinian excerpt (see above) *De absidibus earum*: nearer planets move faster, while motion at apogee is slowest.

Two concentric circles are connected by a number of radial line segments, usually sixteen or more (not twelve). The only elaboration in the diagram is the label written circularly within the outer circle. In all but one case this label is "partes angustantur iuxta terram."

4.2 Text and Translation

Quo monstrato alios circulos videamus. sed quis dubitet solarem circulum duodecies, quam Lunae est, esse maiorem, cum, quod illa mense, ille duodecim currat? Martis vero circulus vicies quater potior invenitur, Iovis centies et quadragies, Saturni trecenties tricies et sexies. unde si numerus intentius supputetur, et quot stadia Saturni circulus habeat, et quota eius portio omnis terra sit, invenitur. nam

si centies Lunae circulus maior est terra, Lunae autem circulo trecenties tricies sexies maior Saturni, maior est igitur Saturni circulus omni terra tricies ter milies et sescenties.[9]

After this demonstration, let us turn our attention to the other orbits. Will anyone doubt that the Sun's orbit is 12 times as great as the Moon's, if the latter completes its orbit in a month and the former in a year? The orbit of Mars is then found to be 24 times as great, Jupiter's 144 times as great, and Saturn's 336 times as great. If the calculations are carried further, we find both the number of stadia in the orbit of Saturn and how many times greater it is than the entire Earth. For if the Moon's orbit is 100 times as great as the Earth and Saturn's orbit is 366 times as great as the Moon's orbit, then the orbit of Saturn is 33600 times greater than the Earth's size.[10]

5 EQUALES-INEQUALES DIAGRAM

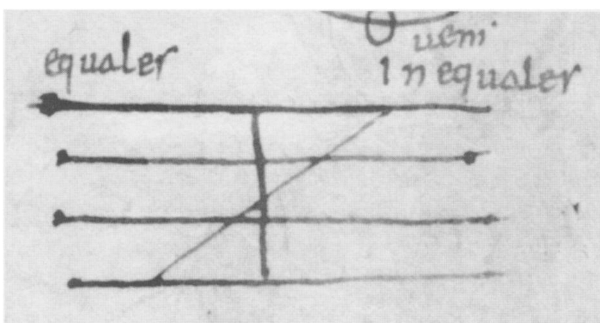

Figure V.5. Equales-inequales. Leiden Universiteitsbibliotheek, Ms. Voss. lat. F.48, f. 92v. Reproduced with permission of the Department of Western Manuscripts, University of Leiden.

5.1 DESCRIPTION

The equales-inequales diagram (Fig. V.5) represents the simple difference between perpendicular (at equal angles) and oblique (at unequal angles) paths, which characterize the different speeds of rising and setting of constellations.

[9] Capella (1983), p. 326. 7-15.
[10] Capella (1977), p. 335.

Across four parallel horizontals are drawn both a diagonal and a perpendicular. These last two lines intersect in the middle space formed by the four parallels. The label "equales-inequales" appears above the diagram. No labels appear on the angles formed within the diagram.

5.2 Text and Translation

Temporum quoque ipsorum, quibus oriuntur aut occidunt, habenda distantia est. nam quae transversa oriuntur et recta occidunt, celeriores ortus habent quam occasus; contra autem quae recta oriuntur et transversa conduntur, tardius oriuntur.[11]

The differences in times required for risings and settings must be explained. Those constellations that rise transversely and set vertically have swifter risings than settings; conversely, those that rise vertically and set transversely have slower risings than settings.[12]

6 Equinoctium Diagram

6.1 Description

The equinoctium diagram (Fig. V.6) represents the balance between added lengths of daylight and subtracted lengths of daylight in the three months before and after each solstice.

Three concentric and equidistant semicircles, extended to form horseshoe-shaped lines, set the framework for this diagram. Within the innermost of the three, a straight line bisects the space and extends to become parallel with the legs of the horseshoe shapes. The six ends of the horseshoes are numbered. From the outside in on each side of the figure the three legs are labeled with numerals, one to three, and often with the words for "first," "second," and "third" as well. The label "equinoctium" appears in the curved section of the diagram.

6.2 Text and Translation

Interea bis climatibus quibusque crescunt decrescuntgue luces, sciendumque a bruma ita dies accrescere, ut primo mense duodecima eiusdem temporis quod additur aestate accrescat, secundo mense sexta, tertio quarta, et quarto mense alia quarta, quinto sexta, sexto duodecima. illud quoque manifestum, quod zodiacus circa Cancrum Capricornumque flexior aequinoctialem paene directim secat.[13]

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[11] Capella (1983), p. 319. 3-6.
[12] Capella (1977), p. 328.
[13] Capella (1983), p. 333. 2-7.

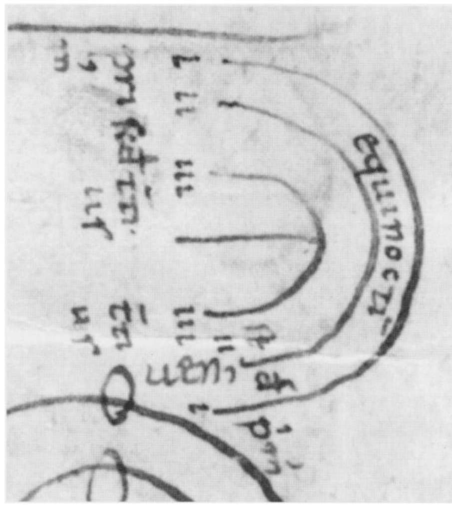

Figure V.6. Equinoctium. Leiden Universiteitsbibliotheek, Ms. Voss. lat. F.48, f. 92v. Reproduced with permission of the Department of Western Manuscripts, University of Leiden.

However, at each climate the days lengthen and again shorten each year; and you must understand that from winter solstice the days increase in length in such a manner that in the first month a twelfth part of the increase to midsummer is added, in the second month a sixth part, in the third month a fourth part, in the fourth month another fourth part, in the fifth month a sixth part, and in the sixth month a twelfth part. The reason for the difference is that the zodiac winds around Cancer and Capricorn but cuts across the equator almost directly.[14]

7 ULTRA DIAGRAM

7.1 DESCRIPTION

The ultra diagram (Fig. V.7) seeks to represent a statement in Capella's text resulting from a corruption of the text. The modern editors do not comment, but medieval scholars considered the text correct with this corruption and sought to make sense of it. Recognizing that the elongation of Mercury from the Sun does not exceed 22° along the arc of the solar circle, the illustrator presents a larger divergence of Mercury from the Sun (up to 32°) somehow below the Sun.

[14]Capella (1977), p. 341.

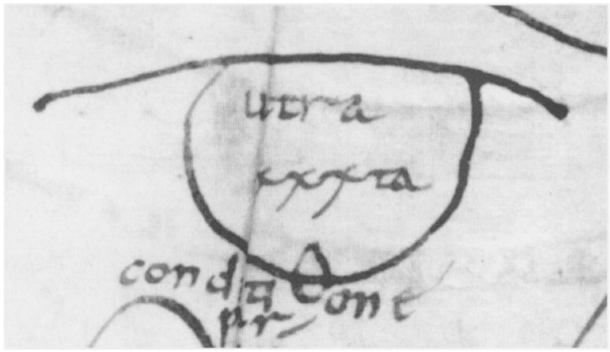

Figure V.7. Ultra. Leiden Universiteitsbibliotheek, Ms. Voss. lat. F.48, f. 92v. Reproduced with permission of the Department of Western Manuscripts, University of Leiden.

From a short arc of large radius, representing part of the circle of the Sun around the Earth, is suspended a shape that is approximately a semicircle, although in some examples it is much more a low-hanging pendant. At the bottom of this semicircle, or pendant, is a small circle, which represents Mercury. Frequently at the top of the figure, on the solar arc, is a small circle to represent the Sun. Neither of these small circles is usually labeled. Within the enclosure formed by the pendant and the arc of the Sun's path is written the phrase from the text of Capella, either "ultra xxxta" or "ultra xxxii," the former being an incomplete form of the latter.

7.2 TEXT AND TRANSLATION

Sed idem Stilbon, licet Solem ex diversis circulis continetur, ab eo tamen numquam ultra XXII (*Ms.* XXXII) partes poterit aberrare nec duobus signis absistere, nunc praeteriens, nunc consistens aut certe regrediens.[15]

This same Stilbon, though it accompanies the Sun in its varied epicycles, will never be able to depart from the Sun by more than 22 (*Ms.* 32) degrees of elongation; never will it be able to be two signs away, as at times it passes by the Sun, then comes to a halt, and then retrogresses.[16]

[15]Capella (1983), p. 333. 14-17.
[16]Capella (1977), p. 341.

8 ECLIPSIS DIAGRAM

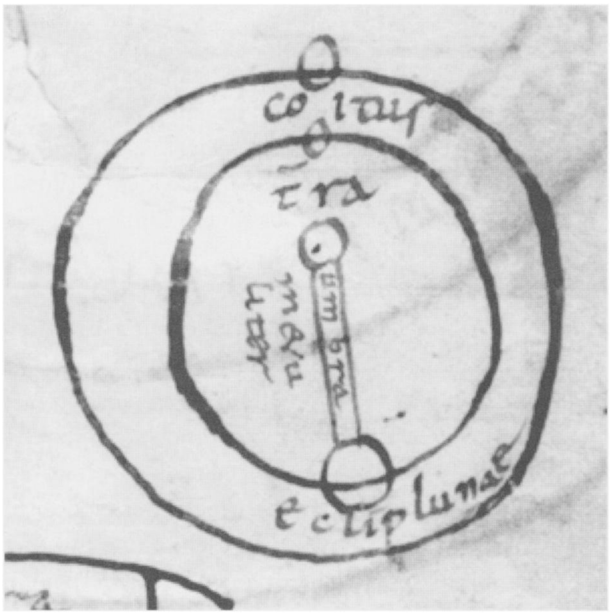

Figure V.8. Eclipsis. Leiden Universiteitsbibliotheek, Ms. Voss. lat. F.48, f. 92v. Reproduced with permission of the Department of Western Manuscripts, University of Leiden.

8.1 DESCRIPTION

The eclipsis diagram (Fig. V.8) combines both solar and lunar eclipses in a single diagram. It presents only the longitudinal motions and accounts for only the most basic elements of solar and lunar eclipse.

The figure combines the elements for a plane representation of both solar and lunar eclipses. Two concentric circles show the paths of Sun and Moon around the Earth, usually labeled and placed in the center of the circles, although sometimes off-center. Vertically and in line with each other, are four small circles, representing the bodies of the Earth and planets involved. Lowest is the body of the Moon on its circle. Next is the Earth, connected to the lunar body by a cone or column for the shadow (*umbra*, when labeled) of the Earth on the Moon below it. Vertically above the Earth is another lunar circle, here for a solar eclipse. Uppermost in the

diagram is the small circle for the body of the Sun. Between the upper lunar circle and the solar circle above it appears the label for "conjunction" (*coitus*).

8.2 TEXT AND TRANSLATION

Verum eadem Luna cum secans solarem lineam in aquilonem scandit, vocatur ὕψος ὑψουμένη, cum ab aquilone ad solarem lineam redit, dicitur ὕψος ταπεινουμένη; cum a solari in austrum descendit, ταπείνωμα ταπεινουμένη; cum deinde rediens ad Solem resurgit, ταπείνωμα ὑψουμένη. sed idem ascensus descensusque faciunt utriusque luminis obscurationem. nam cum Luna scandens descendensve in solarem lineam inciderit, si tricesima est, hoc est omni corpore subiecta Soli, obscurationem Solis terris facit; suo enim corpore subter se positas obscurat, aliis partibus terrae Sole, qua non tegitur, relucente. quam obscurationem ideo non cunctis mensibus facit, quia non semper tricesima in eadem solari linea reperitur, sed aut sursum aut deorsum posita, ne possit obstare, transmittit.

[870] Item Lunae defectus fit, cum in contrario Luna posita, hoc est quinta decima, in eadem linea Solis umbra terrae metaliter infuscatur. nam Sol umbram terrae in suam lineam mittit, quam si Lunae corpus intrarit, quoniam videre lumen Solis terra obstante non poterit, luminis soliti ademptione furvescit; alias, cum in superiore aut inferiore latitudinis loco fuerit, pleni luminis effigie relucescit.[17]

When the Moon cuts across the ecliptic in its northward ascension, it is said to be in ascending elevation; when it is returning to the ecliptic from the north, it is in descending elevation; when it is moving from the ecliptic in a southerly direction, it is in descending declination; and when it is returning from there to the ecliptic, it is in ascending declination. These ascents and descents cause the eclipses of the two bodies. When the Moon, in its ascents or descents, touches the ecliptic, if it happens on the thirtieth day—that is when it lies directly beneath the Sun with its entire body—it causes an eclipse of the Sun on Earth; for by interposing its body, it darkens regions lying beneath it, while other parts of the Earth, which are not covered up, are illuminated by the Sun. The Moon does not cause these eclipses every month, because it is not always found on the ecliptic on the thirtieth day; it is then passing above it or below it, so that it is not in an obstructing position.

[870] Similarly, an eclipse of the Moon occurs when it is located along the line of the ecliptic in a position of opposition; that is, on the fifteenth day. It is darkened by the conical shadow of the Earth. For the Sun sends the shadow of the Earth along its ecliptic line; when the Moon's orb reaches this line, since it will not be able to receive the light of the Sun with the Earth standing in the way, it will become darkened, the customary light being taken away. At other times, when

[17] Capella (1983), p. 329. 2-19.

it is in a position of latitude above or below the ecliptic, it will shine forth with an appearance of full light.[18]

9 THREE VERSIONS OF CIRCUMSOLAR PLANETS DIAGRAM

9.1 DESCRIPTION

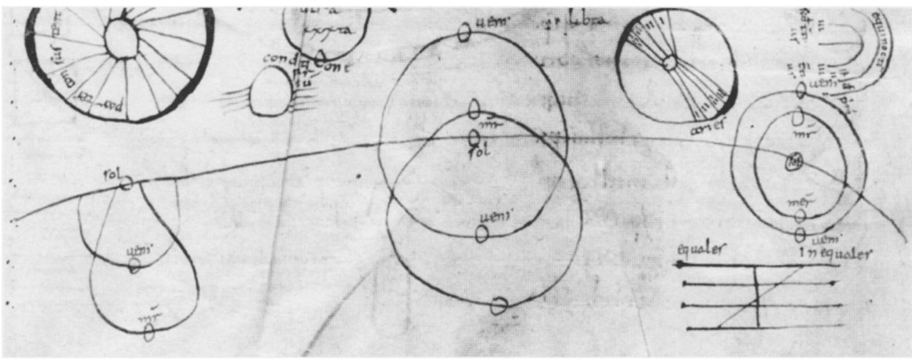

Figure V.9. Three versions of circumsolar planets. Leiden Universiteitsbibliotheek, Ms. Voss. lat. F.48, f. 92v. Reproduced with permission of the Department of Western Manuscripts, University of Leiden.

Figure V.9 combines three diagrams to illustrate not only the text of Capella, but also at least one alternative. The modern edition of the text produces the form with concentric circles. A commonly accepted medieval emendation of the text produces the form with intersecting circles. A related text of Pliny, dealing with the paths of the inner planets but not presented by the medieval illustrator of Capella's text, produces the form with truncated paths that do not cross beyond the path of the Sun.

On a long curvilinear line, often a regular circular arc, appear three diagrams, each a different version of the Venus, Mercury, Sun, circumsolar pattern. Normally the only labels with these diagrams are the planetary names, but a few examples give the names of Pliny, Martianus, and Bede for the three, from left to right along the connecting line. From left to right the three versions have the general appearance, respectively, of truncated paths, intersecting circles, and concentric circles. Each of these three versions appears at times as a separate diagram in the margin of the text of Capella's astronomy. (1) The version on the left side has two

[18]Capella (1977), pp. 337-8.

lines pendant to the solar, connecting line. The pendant for Venus is a semicircle or almost a semicircle. The other pendant, for Mercury, hangs lower in a teardrop shape and intersects the path of Venus. This second pendant has its upper tip cut off by the solar line. The Mercury pendant begins within the semicircle for Venus and then expands as it drops down, cutting the path of Venus and spreading below it to form a pendant about the same width as the semicircle of Venus. On each planetary line appears a small labeled circle for each of the bodies of the Sun, Venus, and Mercury, arranged vertically with respect to one another. (2) The version in the middle has two circles of approximately equal size intersecting each other and the path of the Sun. The upper circle has its center on the solar arc; the lower circle has its center well below the solar arc. Arranged vertically are small labeled circles on each arc in the following ascending order: Mercury, Venus, Sun, Mercury, Venus. (3) The version on the right has two concentric circles with the body of the Sun at their center. In vertical order there appear five small circles, labeled in ascending order as follows: Venus, Mercury, Sun, Mercury, Venus.

9.2 TEXT AND TRANSLATION

Nam Venus Mercuriusque licet ortus occasusque cotidianus ostendant, tamen eorum circuli terras omnino non ambiunt, sed circa Solem laxiore ambitu circulantur. denique circulorum suorum centron in Sole constituunt, ita ut supra ipsum aliquando, infra plerumque propinquiores terris ferantur; a quo quidem uno signo et parte dimidia Mercurius, (Venus vero XLVI partibus) disparatur. sed cum supra solem sunt, propinquior est terris Mercurius, cum intra Solem, Venus, utpote quae orbe vastiore (*Ms.* castiore) diffusioreque curvetur.[19]

Now Venus and Mercury, although they have daily risings and settings, do not travel about the Earth at all; rather they encircle the Sun in wider revolutions. The center of their orbits is set in the Sun. As a result they are sometimes above the Sun; more often they are beneath it, in a closer approximation to the Earth. Mercury's and Venus's greatest elongation from the Sun is one-and-one-half signs. When both planets have a position above the Sun, Mercury is closer to the Earth; when they are below the Sun, Venus is closer, inasmuch as it has a broader (*Ms.* tighter) and wider orbit.[20]

[19] Capella (1983), p. 324. 10-17.

[20] Capella (1977), p. 333. For the significance of the manuscript reading here that is present in virtually every exemplar, see Eastwood (1982*b*).

10 ABSQUE LIBRA DIAGRAM

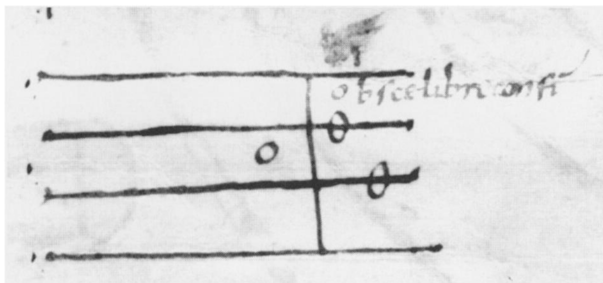

Figure V.10. Absque Libra. Leiden Universiteitsbibliotheek, Ms. Voss. lat. F.48, f. 92v. Reproduced with permission of the Department of Western Manuscripts, University of Leiden.

10.1 DESCRIPTION

The absque Libra diagram simply uses a vertical line to demarcate the beginning of the sign of Libra and then shows the Sun at midlatitude before entering the sign while showing the Sun one-half a degree above and below its previous latitude after entering Libra.

Four horizontal parallels, equally spaced, are cut by a vertical line. To the left of the vertical there appears a small circle in the middle space formed by the four parallels. To the right of the vertical there appear two small circles, one bisected by the second parallel down, the other bisected by the third parallel down. These two circles to the right of the vertical are placed with the upper circle distinctly to the left of the lower circle. On the right side of the vertical line there appears above the four parallels the letter "L." Below the top parallel, to the right of the vertical line, is the phrase from the text, "absque Libre confinio," or some variant of this.

10.2 TEXT AND TRANSLATION

Sol enim in nullam excedens partem medio libramento fertur absque ipso Librae confinio; nam ibi se in austrum aquilonemve deflectit ad dimidium fere momentum.[21]

[21] Capella (1983), p. 328. 14-16.

The Sun's course does not depart from the ecliptic except in the sign of Libra, where it is deflected to the north or the south by half a degree.[22]

11 ECCENTRON SOLIS DIAGRAM

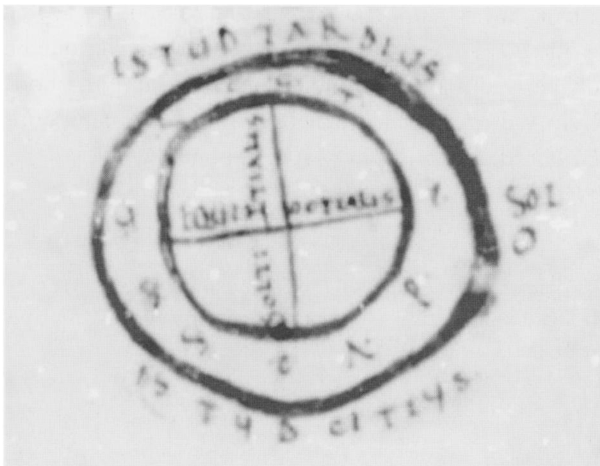

Figure V.11. Eccentron solis. Leiden Universiteitsbibliotheek, Ms. Voss. lat. F48, f.81r. Reproduced with permission of the Department of Western Manuscripts, University of Leiden.

11.1 DESCRIPTION

The eccentron solis diagram (Fig. V.11) represents an explanation, by way of an eccentric solar circle, of the unequal lengths of the four seasons resulting from a uniformly moving Sun. This figure never appears among the group of ten, described above, that are often found appended together to Capella's text. It shows two circles, one inside the other and eccentric to it. The center of the inner (zodiacal) circle is vertically, or close to vertically, above the center of the outer (solar) circle. The inner circle has a diameter drawn horizontally and another drawn perpendicular to it. The horizontal diameter has the label "equinoctialis." The vertical diameter has the label "solstitialis." Beyond the outer circle and directly above the vertical solstitial line is the phrase "istud tardius." Directly below the vertical solstitial line and beyond the outer circle is the phrase "istud citius." Outside

[22]Capella (1977), p. 337.

the larger circle and to the right of the equinoctial line is a small circle with the label "sol." Between the outer and inner circles there appear in some examples, in counterclockwise order, the initial letters of the names of the zodiacal signs.

11.2 TEXT AND TRANSLATION

Cum sint duo hemisphaeria, unum ab aequinoctiali circulo in septentrionem, aliud in austrum ab eodem aequinoctiali, tamen Sol diversa utrumque ratione transcurrat, cum, ut dixi, paria sint signia partis utriusque. verum id, quod ad solstitialem consurgit, CLXXXV diebus et triente diei noctisque, id autem, quod ad brumalem deprimitur, CLXXX diebus peragitur; quod utique illa res facit, quod eccentron Solis circulo dixi esse tellurem et in superiore hemisphaerio altius tolli, in inferiore ad terrae confinia propinquare. dubium autem non est citius transcurrere breviorem sinum tardiusque diffusum.[23]

Although the two hemispheres are of equal dimensions—one from the equator to the north pole, the other from the equator to the south pole and although, as I have mentioned, the signs on either side are equal, the Sun nevertheless courses through them in unequal periods. It completes its ascending course to the summer tropic in 185 1/4 days, and its descending course to the winter tropic in 180 days. The obvious cause of the discrepancy is that, as I have said, the Earth is eccentric to the Sun's orbit, which is more elevated in the upper hemisphere and draws closer to the Earth in the lower. There is no doubt that the Sun courses over its shorter curve more swiftly and over its more extended curve more slowly.[24]

12 CIRCUMSOLAR CONCENTRIC DIAGRAM

12.1 DESCRIPTION

An arrangement with Venus and Mercury on concentric circles around the Sun, this type of diagram has a usual order with Venus on the outer circle and Mercury on the inner circle, while the Sun appears either on an arc or on its full circle. The Earth may or may not appear as the body around which the Sun revolves. This diagram may or may not include further planetary circles or the zodiacal circle. The diagram is not connected to any other planetary diagram in the way that the elements of the Three versions are connected. One unusual version (version x) shows Venus on an oval and Mercury on a circle, with the oval cutting the circle on both sides, longitudinally with respect to the Sun. See description and text for Three versions (Sections 9.1-9.2).

[23] Capella (1983), pp. 330.22-331.8.
[24] Capella (1977), p. 339.

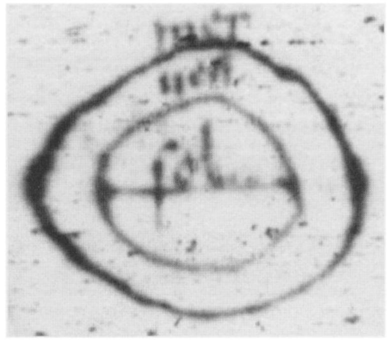

Figure V.12. Cirumsolar concentric. Vaticano Biblioteca Apostolica Vaticana, Ms. Regin. lat. 1987, f. 127v. © Biblioteca Apostolica Vaticana (Vatican).

13 CIRCUMSOLAR INTERSECTING DIAGRAM

13.1 DESCRIPTION

An arrangement with Venus and Mercury on intersecting circles around the Sun, in this type of diagram (Fig. V.13) Venus usually appears on the uppermost circle in the pattern, producing the resultant planetary sequence from the Moon outward: Mercury, Venus, Sun, Mercury, Venus. The two intersecting circles are usually about the same size, although the circle of Venus may be significantly larger than that of Mercury. The Sun may appear either on an arc or on its full circle. The Earth may or may not appear as the body around which the Sun revolves. This diagram may or may not include further planetary circles or the zodiacal circle. The diagram is not connected to any other planetary diagram in the way that the elements of the Three versions are connected. See description and text for Three versions (Sections 9.1-9.2).

14 CIRCUMSOLAR PENDANT DIAGRAM

14.1 DESCRIPTION

The circumsolar pendant diagram (Fig. V.14) is an arrangement with Venus and Mercury each located on a part of a pendant circle or oval or other closed curve. The pendant for each planet is formed by the truncation of the top, or outside, of a closed curve (circle or other) by the path of the Sun. In this arrangement the pendant of Mercury usually hangs lower, bringing this planet closer than Venus to the Earth. The Sun may appear either on an arc or on its full circle. The Earth may

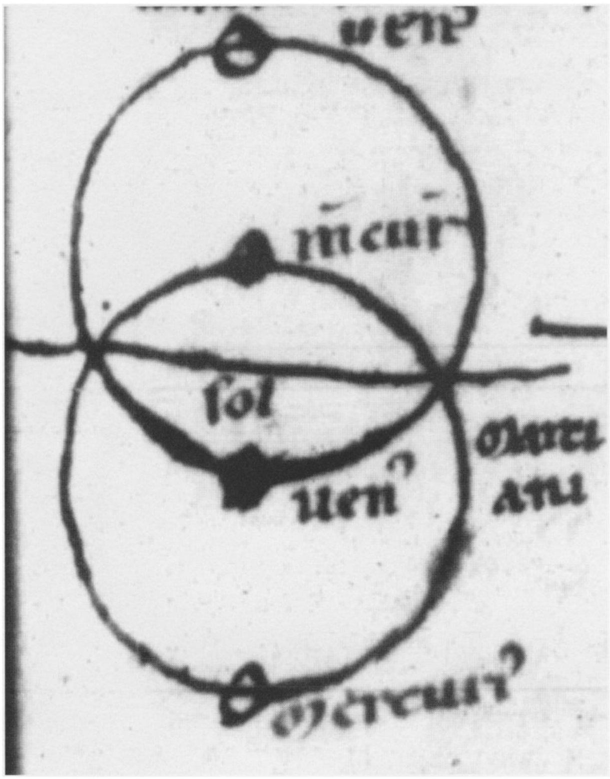

Figure V.13. Circumsolar intersecting. Paris Bibliothèque nationale de France, Ms. lat. 14754, f. 188r. cliché Bibliothèque nationale de France.

or may not appear as the body around which the Sun revolves. This diagram may or may not include further planetary circles or the zodiacal circle. The diagram is not connected to any other planetary diagram in the way that the elements of the Three versions are connected. See description and text for Three versions (Sections 9.1-9.2).

15 SEVEN LUNAR PHASES DIAGRAM

15.1 DESCRIPTION

The seven lunar phases diagram (Fig. V.15) occurs marginally in Capellan manuscripts. Seven stages of waxing and waning Moon are arranged vertically. With full Moon at the fourth position, there appear a crescent, a half, and a gibbous Moon

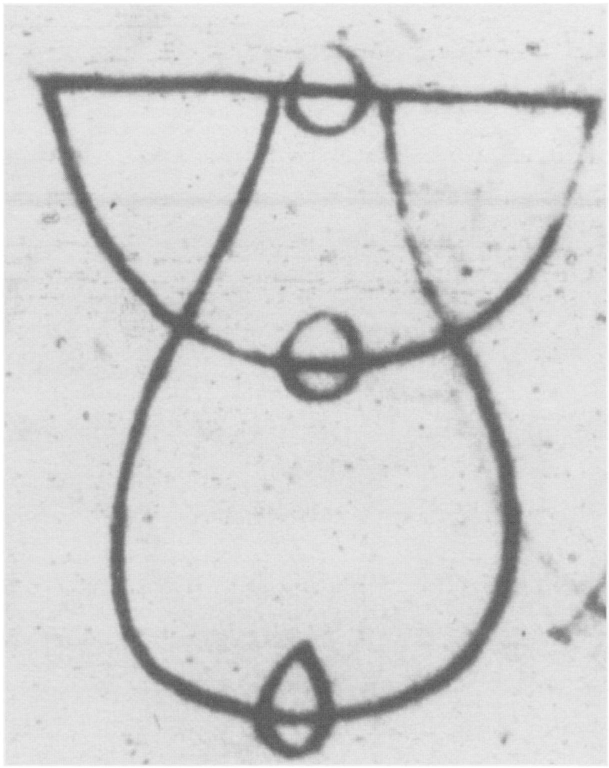

Figure V.14. Circumsolar pendant. Paris Bibliothèque nationale de France Ms. lat. 8669, f.122v. cliché Bibliothèque nationale de France.

in vertical descent to the full Moon and the same three in reverse order decending from the full Moon downward.

16 RADIAL LINES DIAGRAM

16.1 DESCRIPTION

From the center of a circle four, or five, lines radiate more or less horizontally to the periphery of the circle. The radial lines usually appear slightly curved or waving. The origin and meaning of this diagram (Fig. V.16) are unknown. One feasible hypothesis for its graphical origin points to the appearance soon after the middle of the ninth century of one or more manuscripts with an unlabeled form of the Aries-Libra diagram. We have at least one such manuscript in which this

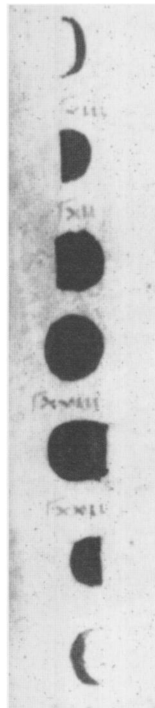

Figure V.15. Seven lunar phases. Leiden Universiteitsbibliotheek, Ms. BPL 88, f. 162v. Reproduced with permission of the Department of Western Manuscripts, University of Leiden.

diagram has the central one of its five radial lines oriented vertically both below and above its center. This manuscript also shows the same diagram rotated 90°, producing a possible origin for the radial lines diagram. We offer no hypothesis for a meaning of this diagram.

17 TERRA DIAGRAM

17.1 DESCRIPTION

A small oval or irregular shape has a label, "terra." The origin of the diagram (Fig. V.17) is unclear. Its significance as a Capellan diagram is uncertain.

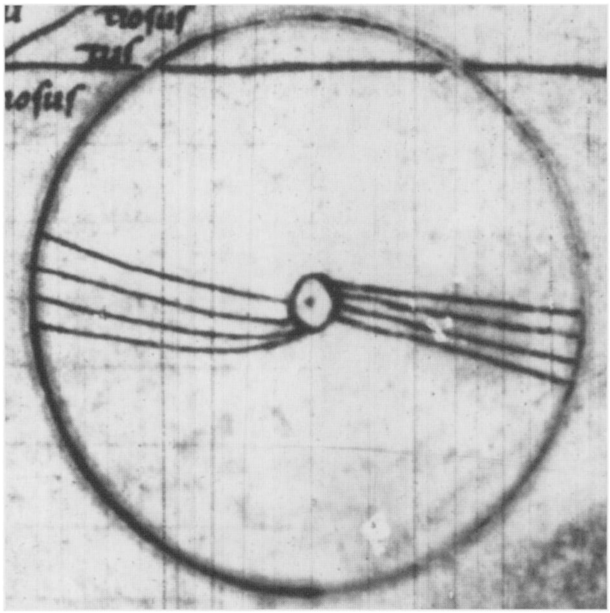

Figure V.16. Radial lines. Paris Bibliothèque nationale de France, Ms. lat. 8671, f. 84r. cliché Bibliothèque nationale de France.

Figure V.17. Terra. Vaticano Biblioteca Apostolica Vaticana, Ms. Urb. lat. 329, f.139v. © Biblioteca Apostolica Vaticana (Vatican).

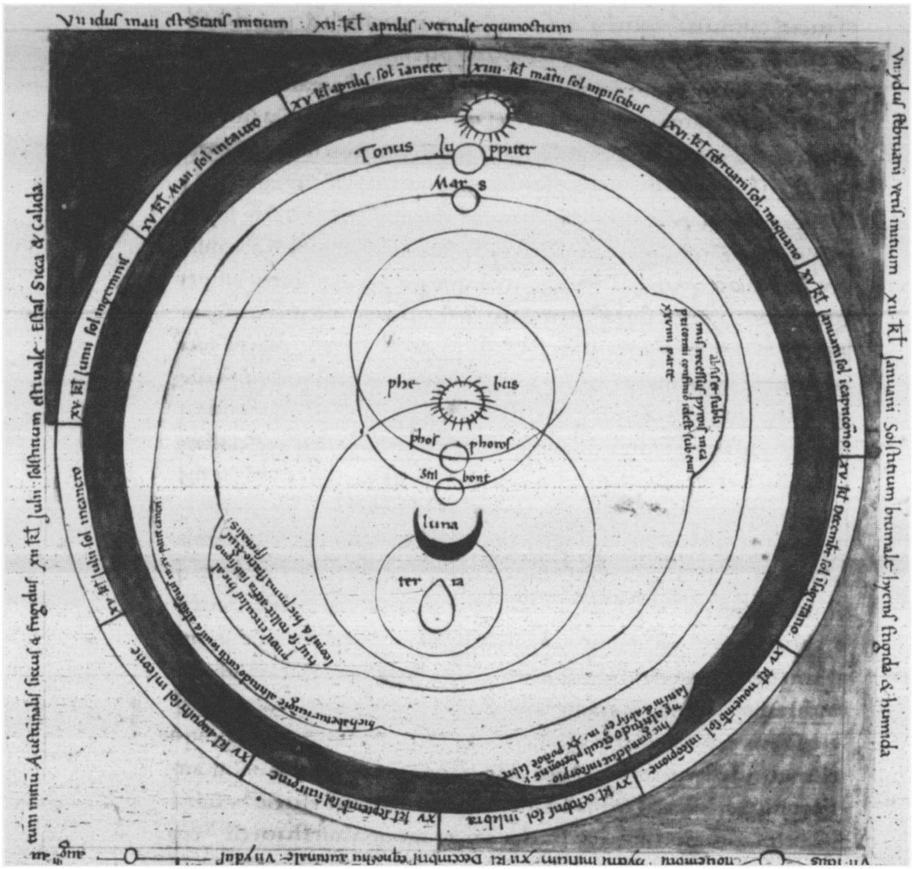

Figure V.18. Capellan planetary theory (apsides). Vaticano Biblioteca Apostolica Vaticana, Ms. Urb. lat. 329, f.139v. © Biblioteca Apostolica Vaticana (Vatican).

18 CAPELLAN PLANETARY THEORY DIAGRAM

18.1 DESCRIPTION

Appearing in two forms, both fairly elaborate, the Capellan planetary theory diagram (Fig. V.18) includes a number of aspects of planetary motion. The more common form, labeled "apsides" in the catalogue, includes the planetary apsides as described in Capella's text, which appear as tumors (bumps) on the planetary paths. The alternative and less frequent form, labeled "rectus ascensus," does not include apsides and shows the paths of the planets to be combinations of vertical

lines on the sides and connecting arcs at top and bottom of the diagram. Both forms display Venus and Mercury as circumsolar intersecting paths. Both forms locate the Earth away from the center of the diagram. Neither form represents a section of Capella's text; both are combinations of many elements of Capella's text. This diagram always appears as a large image, dominating the page. If it appears in combination with a group of other diagrams, appended to Capella's text, the planetary theory diagram is much larger than any other single diagram on the page.

19 CATALOGUE OF MANUSCRIPTS

Label	Library Reference	Century
Cap1	Besançon BM, 594, f. 72r	IX
Cap2	Besançon BM, 594, f. 72v	IX
Cap3	Erfurt StB, Ampl. Q.351, f. 13v	XII
Cap4	Firenze BML, Plut. 51.13, f. 128V	XV(1490)
Cap5	Firenze BML, San Marco 190, f. 102r	XI(in)
Cap6	Firenze BRc, 1221, f. 10v	XII
Cap7	Firenze BRc, 916, f. 88r	XII
Cap8	Karlsruhe LB, Aug. CLXVII, f. 16r	IX(850)
Cap9	Leiden UB, BPL 144, f. 90ry	XII
Cap10	Leiden UB, BPL 36, f. 129r	IX
Cap11	Leiden UB, BPL 64, f. 46v	XI
Cap12	Leiden UB, BPL 87, f. 124v	IX
Cap13	Leiden UB, BPL 88, f. 162r	IX
Cap14	Leiden UB, BPL 88, f. 162v	IX
Cap15	Leiden UB, Voss. lat. F.48, f. 79r	IX(m)
Cap16	Leiden UB, Voss. lat. F.48, f. 79v	IX(m)
Cap17	Leiden UB, Voss. lat. F.48, f. 81r	IX(m)
Cap18	Leiden UB, Voss. lat. Q.79, f. 93V	IX(2/4)
Cap19	London BL, Harl. 2650, f. 32r	XII
Cap20	Milano BA, E.5 sup., f. 26r	XII(2/2)
Cap21	Dijon BM, 448, f. 73v	XI(2/2)
Cap22	München SB, clm 4563, f. 23r	XI
Cap23	München SB, clm 14663, f. 43v	XII(ex)
Cap24	München SB, clm 14729, f. 221v	IX-X
Cap25	Napoli BN, V.A.11, f. 42v	XII
Cap26	Napoli BN, V.A.16, f. 228v	XV
Cap27	Oxford Merton CL, 291, f.94v	XII(m)
Cap28	Paris BNF, lat. 14754, f. 188r	XII(3/4)
Cap29	Paris BNF, lat. 8669, f.122v	IX(2/3)
Cap30	Paris BNF, lat. 8671, f. 84r	IX
Cap31	Paris BNF, nal 340, f. 83r	X
Cap32	Paris BNF, nal 340, f. 83r	X
Cap33	Paris BNF, nal 340, f. 83r	X
Cap34	Paris BNF, lat. 13955, f. 51v	IX(m)
Cap35	Paris BNF, lat. 13955, f. 52r	IX(m)
Cap36	St. Gallen StiB, 248, p. 82	IX

Label	Library Reference	Century
Cap37	Vaticano BAV, Palat. lat. 1577, 55v	XI(in)
Cap38	Vaticano BAV, Palat. lat. 1577, 56r	XI(in)
Cap39	Vaticano BAV, Regin. lat. 1987, f. 127v	IX(ex)
Cap40	Vaticano BAV, Regin. lat. 1987, f. 128r	IX(ex)
Cap41	Vaticano BAV, Urb. lat. 329, f.139v	XV(1474-1482)
Cap42	Venezia BN, lat. XIV.35, f. 143r	XV(1485)
Cap43	Wien NB, cod. 266, f. 111v	XI(in)
Cap44	Wien NB, cod. 266, f. 112r	XI(in)

20 CATALOGUE OF DIAGRAMS

a	appears as an individual diagram in margin of text.
b	appears as a member of a group as an appendage to Capella's text.
c	circumsolar pattern abstracted from other astronomical circles (only Venus, Mercury, Sun, with or without earth).
d	circumsolar pattern in diagram including one or more other usual planetary and zodiacal circles.

Label	Diagram Type	Comment
Cap4	Absque Libra	b
Cap5	Absque Libra	b
Cap10	Absque Libra	b
Cap30	Absque Libra	b
Cap38	Absque Libra	b
Cap41	Absque Libra	b
Cap42	Absque Libra	b
Cap44	Absque Libra	b
Cap1	Acutis-spatiosis	a
Cap10	Acutis-spatiosis	b
Cap30	Acutis-spatiosis	b
Cap35	Acutis-spatiosis	a
Cap37	Acutis-spatiosis	b
Cap42	Acutis-spatiosis	b
Cap43	Acutis-spatiosis	b
Cap4	Capellan planetary theory	b, Apsides
Cap5	Capellan planetary theory	b, Apsides
Cap22	Capellan planetary theory	Apsides (exaltations), calendrical locations
Cap37	Capellan planetary theory	b, Rectus ascensus
Cap41	Capellan planetary theory	b, Apsides
Cap42	Capellan planetary theory	b, Apsides
Cap43	Capellan planetary theory	b, Rectus ascensus
Cap8	Circumsolar concentric	a, d
Cap8	Circumsolar concentric	c, version x
Cap13	Circumsolar concentric	a, c
Cap15	Circumsolar concentric	a, c

Label	Diagram Type	Comment
Cap18	Circumsolar concentric	d
Cap19	Circumsolar concentric	a, d
Cap28	Circumsolar concentric	b
Cap29	Circumsolar concentric	b, no labels, alternative to other concentric image on this page
Cap36	Circumsolar concentric	d
Cap36	Circumsolar concentric	c, version x
Cap39	Circumsolar concentric	a, c
Cap3	Circumsolar intersecting	d
Cap6	Circumsolar intersecting	a, c
Cap9	Circumsolar intersecting	c
Cap12	Circumsolar intersecting	a, c
Cap14	Circumsolar intersecting	a, c
Cap16	Circumsolar intersecting	a, c
Cap19	Circumsolar intersecting	a, d
Cap20	Circumsolar intersecting	a, c
Cap23	Circumsolar intersecting	a, c
Cap28	Circumsolar intersecting	b
Cap29	Circumsolar intersecting	b, no labels
Cap29	Circumsolar intersecting	b, no labels
Cap40	Circumsolar intersecting	a, c
Cap16	Circumsolar pendant	a, c
Cap28	Circumsolar pendant	b
Cap29	Circumsolar pendant	b, no labels
Cap4	Condicione partium	b
Cap5	Condicione partium	b
Cap10	Condicione partium	b
Cap24	Condicione partium	b
Cap30	Condicione partium	b
Cap38	Condicione partium	b
Cap41	Condicione partium	b
Cap42	Condicione partium	b
Cap44	Condicione partium	b
Cap2	Eccentron solis	a
Cap17	Eccentron solis	a
Cap1	Eclipses	a
Cap4	Eclipses	b
Cap5	Eclipses	b

Label	Diagram Type	Comment
Cap10	Eclipses	b
Cap24	Eclipses	b
Cap27	Eclipses	b
Cap30	Eclipses	b
Cap38	Eclipses	b
Cap41	Eclipses	b
Cap42	Eclipses	b
Cap44	Eclipses	b
Cap4	Equales-inequales	b
Cap5	Equales-inequales	b
Cap10	Equales-inequales	b
Cap24	Equales-inequales	b
Cap29	Equales-inequales	b, no labels
Cap30	Equales-inequales	b
Cap37	Equales-inequales	b
Cap41	Equales-inequales	b
Cap42	Equales-inequales	b
Cap43	Equales-inequales	b
Cap4	Equinoctium	b
Cap5	Equinoctium	b
Cap10	Equinoctium	b
Cap24	Equinoctium	b
Cap27	Equinoctium	b
Cap29	Equinoctium	b, no labels
Cap30	Equinoctium	b
Cap37	Equinoctium	b
Cap41	Equinoctium	b
Cap42	Equinoctium	b
Cap43	Equinoctium	b
Cap4	Libra-Aries	b
Cap5	Libra-Aries	b
Cap10	Libra-Aries	b
Cap24	Libra-Aries	b
Cap27	Libra-Aries	b
Cap29	Libra-Aries	b, no labels
Cap30	Libra-Aries	b
Cap38	Libra-Aries	b
Cap41	Libra-Aries	b

Label	Diagram Type	Comment
Cap42	Libra-Aries	b
Cap44	Libra-Aries	b
Cap4	Partes angustantur	b
Cap5	Partes angustantur	b
Cap10	Partes angustantur	b
Cap27	Partes angustantur	b
Cap30	Partes angustantur	b
Cap38	Partes angustantur	b
Cap41	Partes angustantur	b
Cap42	Partes angustantur	b
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Cap10	Radial lines	b
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Cap4	Terra	b
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Cap41	Terra	b
Cap4	Three versions	b
Cap5	Three versions	b
Cap7	Three versions	b
Cap10	Three versions	b
Cap24	Three versions	b
Cap26	Three versions	b
Cap27	Three versions	b
Cap29	Three versions	b, no labels
Cap30	Three versions	b
Cap38	Three versions	b
Cap41	Three versions	b
Cap42	Three versions	b
Cap44	Three versions	b
Cap4	Ultra triginta	b
Cap5	Ultra triginta	b
Cap7	Ultra triginta	b
Cap10	Ultra triginta	b
Cap24	Ultra triginta	b
Cap26	Ultra triginta	b
Cap27	Ultra triginta	b
Cap30	Ultra triginta	b
Cap38	Ultra triginta	b

Label	Diagram Type	Comment
Cap41	Ultra triginta	b
Cap42	Ultra triginta	b
Cap44	Ultra triginta	b

INDEX OF MANUSCRIPTS WITH DIAGRAMS

To find the types of diagram and how many appear in each manuscript, use the labels to determine the chapters and entries. Diagrams for Pliny (Plin + number) are listed in the catalogues at the end of Chapter II. Similarly, diagrams for Macrobius (Macr + number), Calcidius (Calc + number), and Martianus Capella (Cap + number) are listed at the ends of Chapters III, IV, and V, respectively. Each manuscript is indicated here with the label(s) for the planetary diagrams that it contains.

Zürich ZB Car.C.122: Plin106-108, Macr178
Zwettl StiB 389: Macr179

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